Project acronym: FORGE

Project full title: "Forging Online Education through FIRE"

Grant agreement no: 610889

D6.9 Revised exploitation plan

Deliverable Editor: **Christos Tranoris (UoP)**

Other Contributors: **Alex Mikroyannidis (OU) - Diarmuid Collins (TCD), Daan Pareit (iMinds), Jono Vanhie - Van Gerwen (iMinds), Valina Katsaounou (GRNET) – Olivier Fourmaux (UPMC)**

Reviewers: **Diarmuid Collins (TCD), Valina Katsaounou (GRNET)**

Document Identifier:	FORGE-2016-P-D69	Due Date:	30th September 2016
Version:	1.0	Submission date:	30th September 2016
State:	Final	Distribution level:	Public

This document is part of a research project funded by FP7 Framework Programme. Grant agreement number 610889.

Change Log

Version	Date	Amended by	Changes
0.1	17/7/2016	Christos Tranoris	Outline and assignment of partner responsibilities
0.2	30/7/2016	Christos Tranoris	Preparing the Consolidated version for review
0.3	12/9/2016	Christos Tranoris	Preparing the Final version to be approved
1.0	19/09/2016	Aneta Tumilowicz	Final QA

Table of Contents

List of Tables

List of Figures

List of acronyms

EC: European Commission
DoW: Description of Work
FORGE: Forging Online Education through FIRE
FIRE: Future Internet Research and Experimentation
GRNET: The Greek Research and Technology Network
LMS: Learning Management Systems
OER: Open Educational Resources
OU: The Open University
STEM: Science, Technology, Engineering and Mathematics
SME: Small and Medium Enterprise
TCD: Trinity College Dublin
UoP: University of Patras
UPMC: University Pierre et Marie Curie

1 Executive Summary

This report revises the exploitation plans of partners presented in D6.5 (Dissemination and Exploitation plan for task 6.1) and D6.6 (Dissemination report and exploitation plans). It presents the FORGE elements (from architecture, software elements etc.) that are subject to exploitation. In addition, it describes positioning of the FORGE ecosystem by presenting a business model followed by a cost analysis, as well as the proposed model to follow after the project period.

2 Exploitation objects

The elements that will be subject to exploitation are the architecture, software, methodologies and other public results of the project for courses given to students and other learners. More specifically, the objects that have the potential to demonstrate the added value of FORGE and the project in general and could have further applications through the opening of the FORGE platform are:

- **FORGEBox**: FORGEBox is the component that interconnects learning interactive content with Future Internet Research and Experimentation (FIRE) resources. It comprises a set of services that will provide and host for example the interactive content of widgets, and interface with the FIRE resources via well-known FIRE APIs or with the Fed4FIRE portal. Learning Management Systems (LMSs), eBooks and any future element that wishes to consume FORGE content, will need to discover reference points of widgets and Lab Courses descriptions. FORGEBox instantiations can provide the host of such interactive content.
- **FORGEStore**: FORGEStore is a marketplace for the users' FORGEBox installation. The repository contains shared widgets, FORGEBox services, FIRE adapters and shared interactive courses. All items are developed by the FORGE team members as well as external stakeholders that are interested to create and share learning material for FIRE experimentation.
- **Widget**: A widget is a micro-application performing a dedicated task. FORGE and/or external stakeholders develop a number of widgets that expose FIRE facilities to learners and educators. These widgets function as standalone learning applications that can be embedded inside interactive courses.
- **FIRE Adapters/Services**: A FORGEBox service or FIRE Adapter enables a widget to communicate with the FIRE facilities with the functionality that is required for usage in an eLearning context.
- **Course**: A FORGE course is a self-study learning pathway that leads to achieving certain learning outcomes. Most commonly, the learners will study the course at their own pace, since there is no predefined start or end time. Most of the exploitation objects coming from the Open Call are expected to belong to this category, since most of the external stakeholders are expected to be interested in creating new or complement existing experiment-driven courses.
- **FORGE iBook:** FORGE has developed an interactive eBook in the Apple iBooks format. This is available to download for free via iTunes[1]. The FORGE iBook features selected FORGE courses, which consist of instructional videos, quizzes and self-assessment exercises and offer access to FIRE facilities via interactive widgets.

[1] https://itunes.apple.com/us/book/id1062612920

3 Modelling of the FORGE ecosystem, business model and cost analysis

Ecosystem today

From the perspective of the FIRE experimentation facilities, providing resources and value-added services to course providers can turn into a recurring revenue stream. For the education institutions (e.g. universities), having access to the unique FIRE resources can enable them to provide high quality interactive courses deployed on real hardware. The FORGE project itself provides education enablers. These are ready-to-use interactive widgets as well as entire course bundles running on a real infrastructure that can be integrated in existing course material. The widgets use the FIRE experimentation facilities resources and are available online.

We use Allee's value network analysis[2] to evaluate the ecosystem in more detail. The value network diagram is illustrated in Figure 1 and the value exchanges in

[2] Allee, V. (2000). Reconfiguring the value network. Journal of Business strategy, 21(4), 36-39

Table 1.

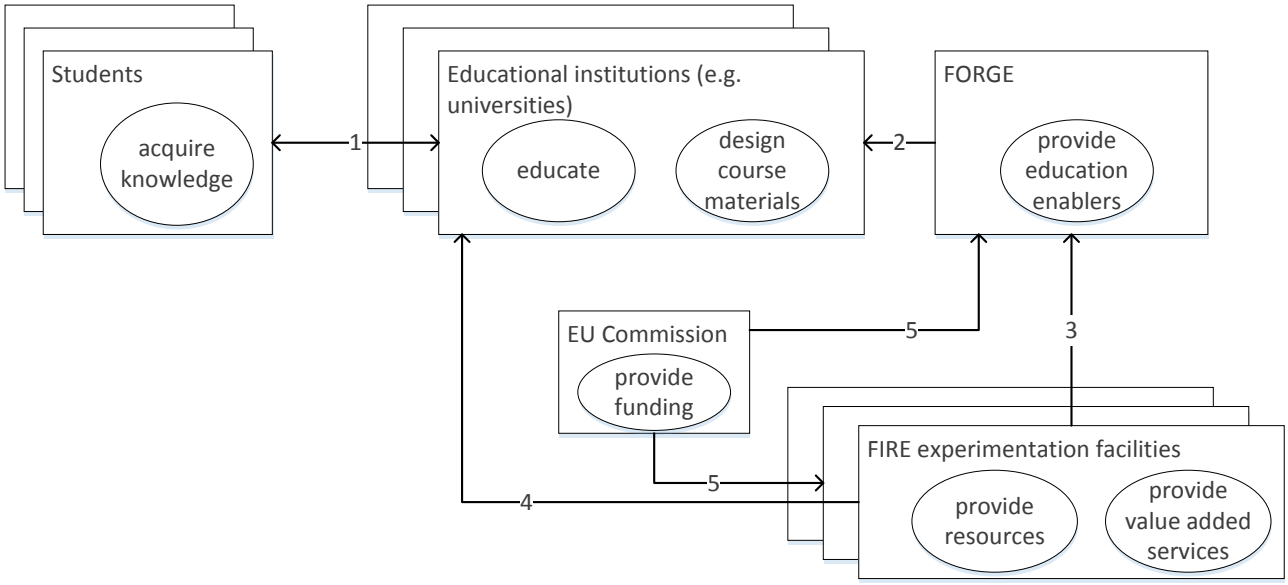

Figure 1 Value network diagram in which educational institutions integrate the FORGE education enablers into course material (e.g. eBooks or lab sessions).

The enablers run on the FIRE experimentation facilities. In today's value network, knowledge and experience with regard to the development of education enablers is available within the FORGE project.

Table 1 Overview of the tangible value exchanges. Note that the IDs used in the first column of this table match with those on Figure 1

ID	Actor (start)	Actor (end)	Description
1	Students	Educational institutions	Students pay a fee for the courses they subscribe to. In return they are thought by an educator for the subject that is supported with course material.
2	Educational institutions	FORGE	Educational institutions integrate the educational enablers in their course materials. Today no charge is asked in return for usage of the educational enablers.
3	FORGE	FIRE experimentation facilities	FORGE tests its interactive material on the FIRE facilities resources. Today no charge is asked in return.
4	Educational institutions	FIRE experimentation facilities	Educational institutions use the FIRE experimentation facilities resources. Today no charge is demanded in return.
5	European Commission (EC)	FORGE, FIRE experimentation facilities	The European Commission enables research by providing guidance, funding and dissemination channels.

We conduct exchange analysis to investigate the general pattern of the exchanges in the network, to check if there is sufficient reciprocity or existence of weak or inefficient links. We can conclude that there is insufficient reciprocity on three links:

- Link 2: the educational institutions do not pay for usage of the education enablers
- Link 3: FORGE does not pay for usage of the FIRE facilities resources
- Link 4: the educational institutions do not pay for usage of the FIRE facilities resources

Today, the EC funding fills in the funding gap for both FORGE and the FIRE facilities. In the remainder we will propose 2 value network configurations in which the EC funding is replaced by new value streams. Of course, these are possible scenarios without any guarantees for actual success.

Future ecosystem

Option 1: Commercialize the results of FORGE via a (spin-off) company

In the value network diagram of Figure 2, the actor FORGE is replaced by a (spin-off) company and the actor European Commission is omitted. To compensate for the loss in funding, the (spin-off) company starts to charge the educational institutions for the usage of the education enablers (value stream 2) and the FIRE experimentation facilities start to charge the educational institutions for the usage of its resources (value stream 4). In addition the (spin-off) company must pay a fee for testing on the FIRE experimentation facilities (value stream 3).

Another option is that the (spin-off) company is a single point of contact for the educational institutions. In that case, value stream 4 will go from the educational institutions towards the (spin-off) company and via the (spin-off) company to the FIRE experimentation facilities.

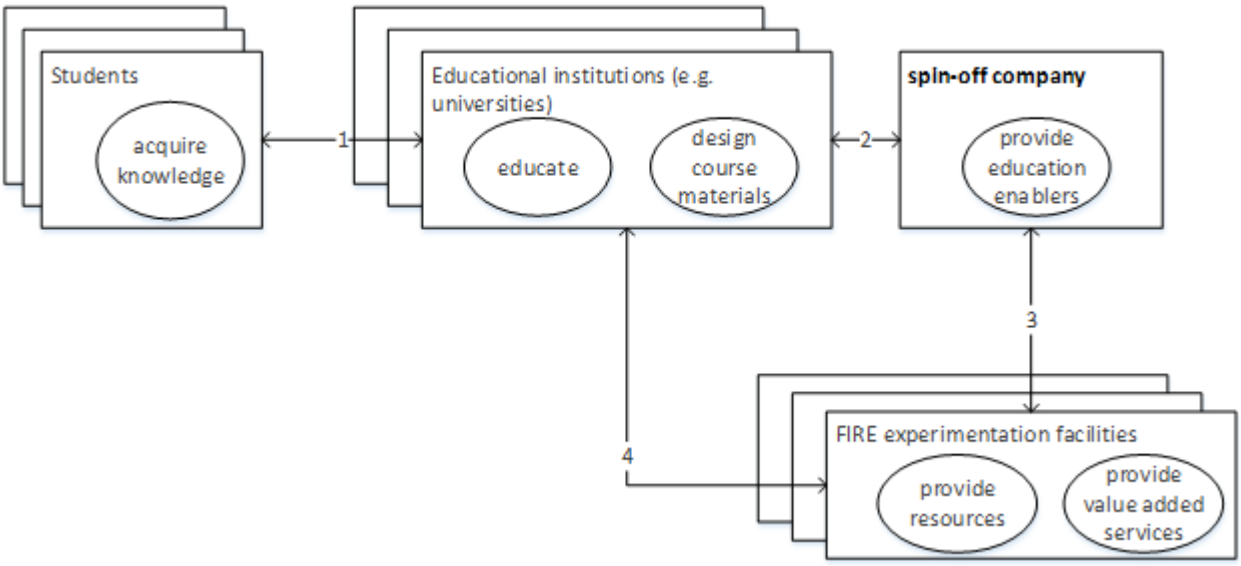

Figure 2 Value network diagram in which a spin-off company is founded to commercialize the results of the FORGE project.

Table 2 Overview of the tangible value exchanges. Note that the IDs used in the first column of this table match with those on Figure 2.

ID	Actor (start)	Actor (end)	Description
1	Students	Educational institutions	Students pay a fee for the courses they subscribe to. In return they are thought by an educator for the subject that is supported with course material.
2	Educational institutions	(Spin-off) company	Educational institutions integrate the educational enablers in their course materials and pay a fee for usage of the educational enablers.
3	(Spin-off) company	FIRE experimentation facilities	The spin-off company tests its interactive material on the FIRE facilities resources. A fee is paid for usage of the resources (and possibly for support).
4	Educational institutions	FIRE experimentation facilities	Educational institutions use the FIRE experimentation facilities' resources during lab sessions in return for a fee.

Exemplary investors in the spin-off could be:

- Specialized course material providers such as Pearson Education
- Educational institutions or associations of educational institutions
- FIRE experimentation facilities

Option 2: Integrate FORGE within the FIRE facilities

In the value network diagram of Figure 3, the role of the FORGE project is integrated with the other roles of the FIRE experimentation facilities. The benefit of this value network configuration is that a single actor combines all roles required to offer interactive courses on real resources.

In addition to the educational institutions (e.g. universities or other institution of higher education), specialized course material providers and private companies who wish to set up training courses for their employees could become customers of the FIRE experimentation facilities.

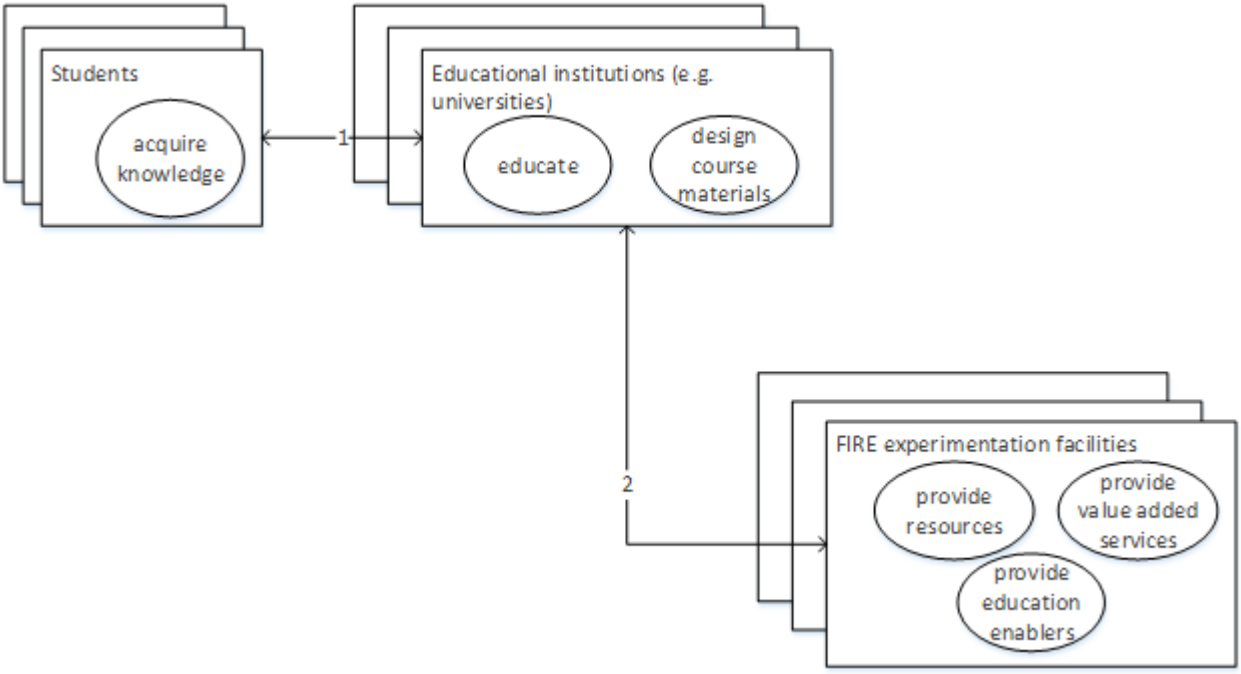

Figure 3 the role of the FORGE project is integrated within the FIRE experimentation facilities who market the educational enablers in combination with the FIRE facilities resources.

Table 3 Overview of the tangible value exchanges. Note that the IDs used in the first column of this table match with those on Figure 3.

ID	Actor (start)	Actor (end)	Description
1	Students	Educational institutions	Students pay a fee for the courses they subscribe to. In return they are thought by an educator for the subject that is supported with course material.
2	Educational institutions	FIRE experimentation facilities	Educational institutions use the education enablers and the experimentation facilities in return for a fee.

Comparison of both options: "Option 1 spin-off company" versus "option 2 integration into FIRE facilities"

Option 1 has as benefit over option 2 that a separate entity is created which may be easier to market than when the offering is part of the FIRE experimentation facilities. Option 2 has as benefit that all roles are closely integrated.

Future business model

Now that today's and the future ecosystem is given shape, we are able to describe a possible business model for the provider of the education enablers. The goal of a business model is to indicate the way value is being generated by interacting with other actors in the ecosystem. We use Osterwalder's business model ontology[3] to clarify the offering (value proposition), how this is implemented, to whom it is offered and how this works financially.

The value proposition consists out of a set of education enablers that are offered towards educational institutions. These education enablers are widgets and course bundles, which can be easily integrated in the course material of educational institutions. The widgets are developed based on a set of generic features, which can be reused in future widgets/courses:

- Reservation module via web interface: to reserve resources online on the FIRE experimentation facilities
- Queuing module: to allow the usage of the same hardware by multiple students
- Integration with other systems: eBooks, learning management systems
- Learning analytics: to keep track of the progress of a student
- (Certification of courses/FIRE facilities – not available today)

The key activity is the development and marketing of the education enablers. These are highly focused functions that should be done by (a team of) educated specialists. Their wage is the main cost for the company offering the educational enablers. Another cost will be the cost for testing on the FIRE facilities. In return for the service, universities, course material providers and ICT companies pay a license fee for the usage of FORGE's enablers.

Figure **4** summarizes the business model. In the next section we estimate the cost of developing and offering an interactive course that uses real resources.

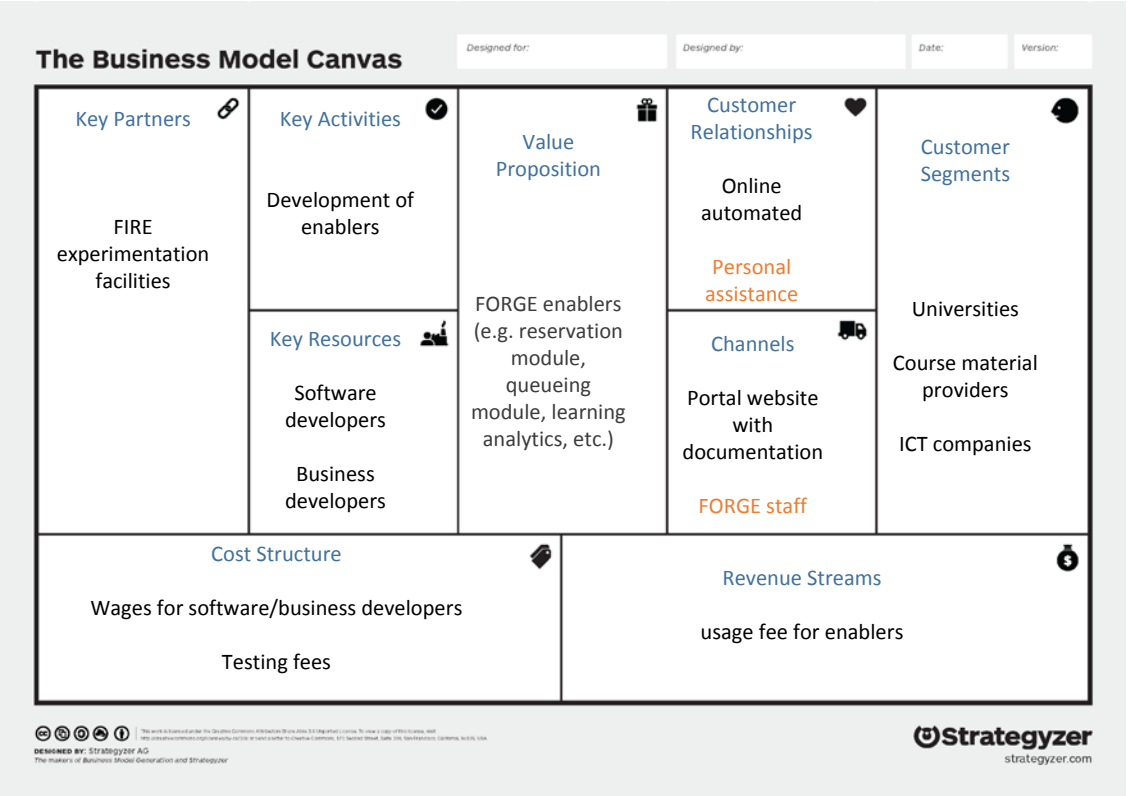

Figure 4 Business model summary

[3] Osterwalder, A., & Pigneur, Y. (2010). Business model generation: a handbook for visionaries, game changers, and challengers. John Wiley & Sons.

Cost model

For universities and course material providers the cost of using the FIRE experimentation facilities' resources consists of two components and has to be calculated per case and according to the institutions' policies:

1. Usage fee for resources

These are quantified via a use case example:

A specialized course on wireless communication is planned with 2 sessions of 2.5h and each with 45 students. The course uses a total of 13 test set-ups (less is feasible but then students have a longer waiting time). Per set-up, 3 nodes are used from iMinds' w-iLab.t facility and 1 node of the iMinds' Virtual wall facility. There is also one virtual server required to be able to manage these resources. We assume that the lab session can be done at the 5GHz range to avoid interference.

The following costs apply:

- Cost per w-iLab.t node per hour (incl. server) = €1.28
- Cost per Virtual wall node: €0.5 per hour and set-up cost of €100.

The total cost for setting up these 2 lab sessions of 2.5h is therefore estimated at: €352.50

- w-iLab.t resources: €250.00 = €1.28 x 3 x 13 x 2 x 2.5
- Virtual wall resources: €102.50 = € 100.00 + 0.5 x 2 x 2.5

2. License fee for getting access to enablers

The license fee for the enablers is dependent on the development cost of the enabler and the number of times it can be licensed. We cannot estimate the second as this would require thorough market analysis but we are able to provide a ballpark estimate of the time required to develop a course:

- The creation of the Rspecs and the scripts to automate network setup: 1 week – 4 weeks per setup
- The development of course materials: 1 day per question.

4 Exploitation plan after the end of the project

The identified current and future ecosystems using the FORGE concept were presented in the previous section, as well as an indication for the implied business and cost models. While the commercialization of offering 'educational enablers' using FIRE facilities could theoretically be done by a dedicated entity, no legal entity showed interest so far. For the time being, we therefore fall back to the scenario where typically only FIRE facilities themselves will offer some education enablers (Without a charging scheme but with a strong focus towards their own facilities of course, although some enablers are interoperable with multiple facilities). Further development depends upon their goodwill and/or on bilateral agreements.

In order for a dedicated entity, offering educational enablers using FIRE, to erect one should investigate more thoroughly the different techno-economics and business aspects which come into play and the required mechanisms to be put in place (e.g. issuing licenses, offering certified courses etc.). The amount of effort and expertise to do this however is considerable and falls outside of the scope of the FORGE project. The 'Common Exploitation Booster' (http://exploitation.meta-group.com/SitePages/default.aspx), supported by the EU, might be useful for similar ends but this initiative will only start after the FORGE project ends.

Nevertheless, the obtained accomplishments within the project itself will be sustainable as each partner within the current FORGE consortium will exploit these individually as described in next

section by e.g. continuing the usage of these flipped labs within the educational programmes of themselves and their partners and/or export them into other platforms (e.g. EIT ICT Labs[4]).

In the white papers of the FIRE community, such as the 'FIRE Vision, Strategy and Roadmap towards 2020' document[5], using FIRE within education platforms is still pinpointed as 'one of the gaps to resolve'. Therefore, the consortium partners will also continue to seek new funding opportunities to collaborate on the combination of eLearning and FIRE:

- (a) by monitoring the different calls within the different units within the EU 'Future Networks' Directorate in DG CONNECT (as the FIRE unit is no longer a separate unit but spread across these different units) and
- (b) by following the specifications and guidelines that will be stipulated by the EU project that will be the successor of Fed4FIRE.

5 Exploitation plans per partner

5.1 OU

The OU will continue collaborating with the Cisco Networking Academy by further developing and extending their joint learning materials and PT Anywhere[6]. The OU and Cisco are seeking to strengthen this collaboration by using PT Anywhere as the vehicle for conducting further research studies beyond FORGE, including research on enhancing the accessibility of network simulations. The FORGE iBook will remain on the highly visible OU channel on iTunes after the end of the project and will be further promoted via the different OU dissemination channels. Finally, the FORGE technological and research outcomes on remote labs and online experimentation will be exploited and extended by new and ongoing Technology-Enhanced Learning and Data Science projects of the OU, including EDSA[7] and SlideWiki[8]. In particular, these projects will build upon the widget-based infrastructure of FORGE for delivering multi-platform interactive learning resources to informal and formal learners.

5.2 University of Patras

During the next 3 years UoP will continue to offer the FORGE course about TCP congestion control to their students of the Network Architectures & Protocols course. For this UoP will proceed to prepare and sign a MoU with iMinds in order to utilize its facilities for the upcoming years. UoP will also try to integrate the FORGEBox technology with the Greek Open Courses initiative (http://www.opencourses.gr/) which contains over 3500 open courses. For this UoP already provides information about the Learning Tools Interoperability (LTI) technology and how this can be exploited with the e-class platform that the Greek Universities extensively use. Moreover UoP will try to integrate material produced by the Open Call by exploring possibilities of integrating parts of them into its own curriculum by different departments of the University (e.g. the Electrical and Computing Engineering Department, the Educational Sciences Department, etc.). Towards this direction, UoP will try to adapt the courses or in certain cases even translate them in Greek in order to deploy them to their students. UoP already considers adopting the two FORGE courses regarding Internet of Things (IoTSTREAMS) and video streaming (ENVISAGE).

5.3 iMinds

iMinds will continue to exploit the FORGE results in multiple ways. The developed courses (and associated adapters and widgets) about WLAN and LTE match the curricula requirements of iMinds' academic partners (e.g. Ghent University) and the curricula of academic consortium and Open Call

[4] http://www.eitdigital.eu/
[5] https://www.ict-fire.eu/wp-content/uploads/White_Paper_2015_on_FIRE_vision_strategy_and_roadmap.pdf
[6] http://pt-anywhere.kmi.open.ac.uk
[7] http://edsa-project.eu
[8] http://slidewiki.eu

partners (e.g. TCD, UoB). These courses, offered via multiple platforms, will therefore be reused and updated during the following academic years. Furthermore, the FORGE courses will attract new researchers and educators who will benefit from iMinds' facilities ("Experimentation as a Service") but were currently not using these or were even unaware of their existence.

The different iMinds FIRE facilities will also remain available for the world wide educational and research audience, considering the importance of these FIRE facilities for iMinds' internal roadmap and for the educational usage within iMinds' affiliated universities. This is proven by the recent move of the facilities to a new location for more expansion opportunities and with an even higher professional support. A capacity increase of these facilities is currently on-going and the merge of iMinds with im[9]ec is promising new exciting opportunities.

5.4 GRNET

GRNET will exploit the results of the project (including prototype and external courses, widgets and tools library, methodology etc.), by promoting them to the Greek universities and research institutions, the GÉANT community and their users and informing them about the benefits of using FIRE facilities for eLearning. Moreover, GRNET will continue offering its advanced network and computational capabilities for access and hosting of the lab course environments.

The dissemination of these will be executed via email campaigning, press releases and posting on social media and by posting onto the official GRNET website the list of the implemented courses and the benefits these can offer to academic and research institutions in Greece. The FORGE approach will also be a part of future cluster campaign open calls to be announced by GRNET to the Greek education and research community. In addition, GRNET will try to establish liaisons and promote the outcomes of the project to SMEs or other companies that use FIRE facilities to perform their research activities, in order to exploit the FORGE tools and platform to create new courses or reuse existing courses for their needs. These courses may be used to present their work to universities or other educational institutions or even inside their company for educational purposes.

5.5 UPMC

UPMC successfully conducted its TCP congestion control course using Planet Lab Europe (PLE) testbed for two years consecutively. This course is part of a Network Computer teaching unit of the UPMC Computer Science master that was accredited by the French education ministry for five years. At least this course using the FORGE UPMC lab will be taught for three more years.

UPMC also provided assistance for an external course called: "The Internet Measurements: a Hands-on Introduction" MOOC[10], which is offered by the French national e-learning platform France Université Numérique (FUN). This course has been developed with the METRO FORGE open call project proposed by INRIA and also uses PLE testbed. This MOOC has been open to public since May 2016 and was conducted successfully once and is ready to be run again (at least one session per year). The operation is ensured by INRIA, as a leading technical player in the FUN platform with a team dedicated to the maintenance of MOOCs. The content is supervised by a teaching staff member of the UPMC which also uses the FORGE lab part for an advanced teaching unit of the UPMC Computer Science Masters. This unit will be taught for at least the next three years.

PLE, the selected FIRE facility for UPMC FORGE labs, has its NOC operated by UPMC and is secured by a national long lasting funding and several commercial clients (like Telefonica). The two FIRE adapters developed for the TCP congestion control course and the MOOC are going to be merged and included in the PLE management tools to guarantee their maintenance and sustainability according to the evolution of the PLE testbed.

5.6 Trinity College Dublin (TCD)

TCD will continue to use courseware and experimentation resources developed and deployed by FORGE consortium members and Open Call partners in the 5C2 Master module curriculum beyond

[9] http://www2.imec.be/
[10] https://www.fun-mooc.fr/courses/inria/41011/session01/about

the lifetime of the FORGE project. To support this activity, we have initiated the creation of bilateral agreements between TCD, iMinds, and UoP to ensure continued support for courses developed. TCD will also continue to offer OFDM course material to existing universities such as Universidade de Brasilia and promote the FORGE courseware across our dissemination network. All material developed through FORGE will be freely available to the public. Furthermore, any new institutions requiring access to TCD courseware and experimentation equipment will be facilitated. TCD also intends to continue developing advanced electrical engineering courses supported by adapters and widgets developed during the FORGE project for the GNU Radio software defined radio framework. Moreover, as a consequence of FORGE, TCD has built a strong education and cooperative working relationship with IT Mexicali[11] in Mexico, which we are already beginning to exploit for research purposes. Furthermore, work on the IEEE Actionable Data Book (ADB) standard started during the FORGE project will continue after the FORGE project ends. Finally, FORGE tools and research material will continue to be utilised by the FUTEBOL[12] project (Grant Agreement No. 688941) to support the project deliverables related to educational outreach.

5.7 NICTA

NICTA will exploit the results of FORGE by continuing its collaboration with local Australian Universities such as the University of Sydney and the University of New South Wales. In particular with the later, NICTA will continue providing support for the “Capacity Planning in Network” course where we developed our advanced course. In relation with the plugin developed within FORGE, NICTA will also continue its support of the LabWiki, OMF and OML plugins and frameworks.

6 Conclusions

This deliverable presented a detailed view of the FORGE ecosystem and tried to define a business model and draft a cost analysis. From the study and for the time being, we proposed the scenario where typically only FIRE facilities themselves will offer some education enablers, without a charging scheme. Further development depends upon their goodwill and/or on bilateral agreements. The deliverable presented also individual exploitation plans by each partner.

[11] http://www.itmexicali.edu.mx
[12] http://www.ict-futebol.org.br