



Transatlantic TUmour MOdel Repositories

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Final Dissemination and Exploitation Plan

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ABSTRACT:

A central goal of the TUMOR project is the development of a pilot repository infrastructure that will support the creation of complex multiscale models of tumour growth and response to various treatment modalities by combining modelling modules eventually developed by different modellers or modelling groups. Such modelling modules may focus on different spatiotemporal scales of biocomplexity. To this end a series of compatibility and reusability issues have already been addressed by the project. A European cancer model repository has been developed and its collaboration potential with US repositories such as the CViT model repository is being demonstrated. Since there are several dissemination and exploitation domains addressed by the TUMOR project, the present deliverable outlines the final dissemination and exploitation plan for each major domain separately. Regarding dissemination, both conference and scientific journal publications are envisaged whereas exploitation is addressed from the basic science, technology, clinical and industrial perspectives.

KEYWORD LIST: TUMOR, TUMOR Project Workshop, 5th International Advanced Research Workshop on *In Silico* Oncology and Cancer Investigation, 5th IARWISOCI, multiscale cancer modelling, *in silico* oncology, transatlantic cooperation, model repositories, dissemination, exploitation

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The TUMOR Project- Final Dissemination and Exploitation Plan Executive Summary

The TUMOR project aims at developing a European *clinically oriented* semantic-layered cancer digital model repository from existing EU projects that will be interoperable with the US grid enabled semantic-layered digital model repository platform at CViT.org (Center for the Development of a Virtual Tumor, Massachusetts General Hospital (MGH), Boston, USA) which is NIH/NCI-caGRID compatible. This interoperable, CViT interfaced, environment will offer a range of services to international cancer modellers, bio-researchers and eventually clinicians aimed at supporting both basic cancer quantitative research and individualized optimization of cancer treatment. This 'Transatlantic' project will therefore be the starting point for an international validation environment, which will support joint applications, verification and validation of the clinical relevance of cancer models. To ensure the clinical relevance of this joint effort, the development of the project is based upon specific clinical scenarios that will be implemented within an integrated EU-US workflow environment prototype for predictive, *In Silico Oncology*-guided clinical studies that are being deployed. As an end result, a specific, clinically relevant workflow involving both EU and CViT models will be demonstrated, which will clearly highlight the need for and added value of interoperability. To achieve these goals, multiscale models/tools developed and data collected within the framework of three ongoing EC funded research projects, namely ACGT [Advancing Clinicogenomic Trials on Cancer], ContraCancrum [Clinically Oriented Cancer Multilevel Modeling] and the VPH NoE [Virtual Physiological Human Network of Excellence], in conjunction with models and data from the NIH supported ICBP Program CViT.org drive the development, optimization and validation of the integrated system. Thus, a new module of the Virtual Physiological Human (VPH) environment will emerge. The present deliverable outlines the final dissemination and exploitation plan for each major domain separately. Regarding dissemination both conference and scientific journal publications are envisaged whereas exploitation is addressed from the basic science, technology, clinical and industrial perspectives.

1. Introduction

The TUMOR project is setting up the scene for the development of a pilot infrastructure that will support the creation of complex multiscale models of tumour growth and response to various treatment modalities by combining modelling modules eventually developed by different modellers or modelling groups. Such modelling modules may focus on different spatiotemporal scales of biocomplexity. To this end a series of compatibility and reusability issues have already been addressed by the project. A European cancer model repository has been developed and its collaboration potential with US repositories such as the CViT model repository is being demonstrated. Since there are several dissemination and exploitation domains addressed by the TUMOR project, the present deliverable outlines the final dissemination and exploitation plan for each major domain separately. Regarding dissemination both conference and scientific journal publications are envisaged whereas exploitation is addressed from the basic science, technology, clinical and industrial perspectives.

2. Final Dissemination Plan

The final dissemination plan of the TUMOR project has been divided into the following sections:

- *Dissemination through presentation of the TUMOR project work and its outcomes in pertinent international conferences and publication in the corresponding conference proceedings.*
- *Dissemination through publication in international peer reviewed journals.*
- *Dissemination through the project public website.*
- *Dissemination through networking with other projects funded under the VPH umbrella.*
- *Dissemination through social media networking.*

2.1 Conferences and Conference Proceedings

A major focused open transatlantic conference within the TUMOR project framework has been the 5th International Advanced Research Workshop on *In Silico* Oncology and Cancer Investigation (5th IARWISOCI) which has also been “The TUMOR Project Workshop” (www.5th-iarwisoci.iccs.ntua.gr). The workshop, which was organized by ICCS-NTUA in collaboration with both TUMOR and non-TUMOR partner organizations from the EU and USA, took place in Athens, Greece on 23-24 October 2012. It proved a complete success. Having been selected to be an IEEE (Institute of Electrical and Electronics Engineers) technically co-sponsored event, it has met the high standards of IEEE-EMBS (Engineering in Medicine and Biology Society). Particular attention has been paid to the peer review procedure undergone by the submitted manuscripts. Furthermore, following a strict evaluation procedure, it has been decided by IEEE that the proceedings of the workshop will be acquired by IEEE-EMBS and made widely available through the Xplore system. Therefore, the workshop papers including several papers directly related to TUMOR will be published in IEEE Xplore within the next two months. In parallel they will be made

freely accessible through the workshop website. Further information is available in the TUMOR Deliverable D6.2.

It is also recalled that within the framework of the TUMOR project, the 4th IARWISOCI (www.4th-iarwisoci.iccs.ntua.gr) as well as the 1st Summer School on Computational Oncology (www.computationaloncology.org) have taken place. Additionally several aspects of the TUMOR project have been presented in the 3rd VPH study group on the VPH Toolkit (<http://vph-institute.org/news/3rd-vph-study-group-on-vph-toolkit>) that took place in Barcelona in May 2012 and the VPH 2012 conference that took place in London in September 2012 (<http://www.vph-noe.eu/vph2012>). Since these past events have already been reported no further information is provided here.

Following a successful first Summer School in Computational Oncology in Heraklion, Crete in 2011, the 2nd Summer School in Computational Oncology will take place from June 23-28, 2013 at Schloss Dagstuhl in Wadern, Germany. The summer school is incorporated in an international network of different EU projects including TUMOR and other initiatives all dealing with the topics “Virtual Physiological Human”, “Modelling/Oncosimulation” and “personalised medicine”. It will be organised by Universität des Saarlandes (USAAR), Germany, in cooperation with the Foundation for Research & Technology – Hellas (FORTH) from Greece and others.

Potential conference events in which aspects of the TUMOR project can also be presented overseas are the following:

The American Society of Clinical Oncology (ASCO) Annual 2013 Meeting, May 31-June 4, 2013, McCormick Place, Chicago, Illinois, USA.
<http://chicago2013.asco.org/>

The International Conference on Predictive, Preventive and Personalized Medicine & Molecular Diagnostics will take place in Chicago from August 5-7th 2013.
<http://www.omicsgroup.com/conferences/personalized-medicine-molecular-diagnostics-2013/cfa.php>

The 35th Annual International Conference of the IEEE Engineering in Medicine and Biology Society, July 3-7, Osaka, Japan, <http://embc2013.embs.org>

The final decision regarding the selection of clinical conference(s) for the presentation of aspects of the TUMOR project will depend on its nearly final outcome.

2.2 Journal Papers

Based on an extensive discussion that took place during the 5th IARWISOCI – The TUMOR Project Workshop with Metin Akay, a member of the IEEE publications committee, a special issue of an IEEE-EMBS journal – probably IEEE Transactions on Biomedical Engineering or IEEE Transactions on Information Technology in Biomedicine – dedicated to *In Silico* Oncology will be launched shortly. TUMOR related papers will be submitted to this issue.

Other TUMOR project related journal papers are to be submitted to other biomedical information technology oriented journals presenting the TUMOR outcome from

various standpoints. For example the output from WP4 in conjunction with other workpackages will be disseminated in a journal paper that is in progress describing TumorML in detail including the most important XML schema sections on model curation, interface description, and model linking. The paper will also give the transatlantic workflow as an exemplar of model composition from multiple submodels, taken from both sides of the Atlantic (EU and CViT). It is planned to submit this paper to either Oxford Journals Bioinformatics or BMC Bioinformatics.

2.3 Project Public Website

The project website is live at <http://tumor-project.eu/>. This platform is and will be used to promote the project, to present the project's latest news, to present the project's partners, and the work of the individual work packages.

2.4 Networking with Other Projects

TUMOR is networking with many other projects funded under the European Commission Framework programmes. These include ACGT, p-medicine, ContraCancrum, CONTRACT, CHIC, MyHealthAvatar, Dr THERAPAT and others.

Such networking helps to specifically sustain software, repositories, tools and models developed within TUMOR. Ongoing projects will be able to re-use them. Gained knowledge about interfacing with US partners will be spread within these projects and the research community.

2.5 Social Media Networking

VPH community and more specifically the In Silico modelling community has been evolving during the last years under the auspices of the European VPH related initiatives and funding. To further strengthen the in-silico modelling community building, we will bring in social media technologies to *advance Cancer research by actively engaging researchers and practitioners*. More specifically, we plan to publish a YouTube video clip summarizing the TUMOR objectives and contribution so far. In addition, we plan to use social media and specifically twitter, as the vehicle to decrease diffusion time for cancer research and innovations. Twitter infrastructure is used to provide status updates for the interested users. We will use the TUMOR workflow application as a twitter user holding a "broadcast" account for news, notifications, etc. The users will be encouraged to become followers in order to get updates for new features of the application, general news, etc., but also for being able to receive personalized "direct messages" from the application.

3. Final Exploitation Plan

The final exploitation plan has been divided into the following four distinct domains:

- Basic science.
- Technology.
- Clinics.
- Industry.

In the following each domain is addressed separately.

3.1 Basic Science

The TUMOR project outcome will be exploited within the basic science domain in the following major ways:

- a. Locating cancer models with specific characteristics within cancer model repositories.
- b. Retrieving, executing and studying models residing in repositories (under restrictions).
- c. Combining available models so as to construct “hypermodels” i.e. complex models in which detailed descriptions of various biological processes taking place at different spatiotemporal levels are taken into account.
- d. Using models and hypermodels in order to study several aspects of the behaviour of cancer e.g. optimal treatment windows in the generic context.

Within this framework a number of new research projects recently funded by the European Commission such as the Integrated Project CHIC (Computational Horizons in Cancer: Developing Meta- and Hyper-Multiscale Models and Repositories for *In Silico* Oncology), MyHealthAvatar (Demonstration of a 4D Digital Avatar Representation for Access to Long-Term Health Status Information) and DR THERAPAT (Digital Radiation Therapy Patient) are expected to make partial use of the European component of the TUMOR outcome. The participation of the University of Pennsylvania, USA in the CHIC project will ensure the continuation of the transatlantic character of the TUMOR endeavour in the basic science context.

3.2 Technology

The TUMOR project outcome will be exploited within the information technology domain in the following major ways:

- a. Developing large scale cancer (and/or other disease or physiological systems) model repositories where models developed by several different modellers could reside and easily retrieved.
- b. Providing an intuitive Workflow environment, as a web based application for constructing complex, multiscale models through the means of workflow technologies, on order to partially automate the technological process of model

linking and the development of hypermodels by utilizing widely acceptable semantic descriptions of the models (meta-modelling).

c. Contributing to the formulation and the advancement of *in silico* medicine, being viewed as the next evolutionary phase of the Virtual Physiological Human (VPH) initiative.

Within this framework certain technological components of the CHIC project will make use of the European repository and its technologies developed within the framework of the TUMOR project. More specifically, The EU TUMOR repository will be used as a basis for the development of the model repository to be created in the recently funded CHIC project (ICCS is the leader of the corresponding WP). Special focus will be put to the combination of the outcome of the TUMOR project with the outcome of the RICORDO project. A special TUMOR-RICORDO meeting was held in September 2012 in this context. . Moreover the overall technological know-how of the TUMOR project will be transferred to CHIC, MyHealthAvatar and other relevant projects.

With a view to promoting the longevity and uptake of TumorML, one of the outputs from WP4, the XML schema, associated transformation stylesheets, and software tools, are to be all open-sourced. Currently the XML schema has been made available open-source on SourceForge (www.sf.net/p/tumorml) under the GNU Library or Lesser General Public License version 2.0 (LGPLv2). Apart from encouraging adoption as a standard for wrapping cancer models in markup, making the specification and schema open will allow future adopters of TumorML to contribute to developing the schema further. As requirements of the cancer modelling community becomes more refined or changes, and new use cases found for use of TumorML outside of TUMOR and related projects, the community can therefore directly engage with TumorML through discussion, support requests, bug reporting and feature requests, and direct contributions towards the software codebase. Supporting software for TumorML being developed in the remaining lifetime of the project will also be released under the same license and SourceForge project to facilitate uptake.

3.3 Clinics

The TUMOR project outcome will be exploited within the clinical domain in the following major ways:

a. Clinically adapting and validating cancer models and hypermodels within the framework of clinical trials.

b. In the mid- and long term, optimally designing and interpreting new clinical trials through the utilization of validated models and hypermodels.

c. In the mid- and long term, optimizing cancer treatment in the patient individualized context through experimenting *in silico* on available models and hypermodels and taking into account the patient's multiscale data. In this context the

knowledge gained within TUMOR regarding for example nephroblastoma is now further used and developed in p-medicine. Within the next Nephroblastoma trial of p-medicine and CHIC the Oncosimulator will be tested in the clinical setting.

3.4 Industry

Although the TUMOR project consortium does not include any industry as a standard partner due to its early exploratory character, future industrial application scenarios of post-TUMOR work that will at least partly exploit the TUMOR outcome could be the following:

- a. As in several complex software frameworks, the hypermodelling framework in itself is distributed freely as an open source project, but a start-up venture company could provide support services to develop advanced and customized versions, and offer consulting for the application side in industry.
- b. A business environment emerges where industries and healthcare organizations license a deployed and supported hypermodelling infrastructure to run their hypermodels internally, and hire external consultants to develop new models (see (a)), or to deal with workload exceeding the internal person bandwidth.
- c. Commercial cancer modelling tools adopt TumorML as a standard format for model representation, independently from the TUMOR infrastructure.

4. Conclusions

In this document an outline of the final dissemination and exploitation plan of the transatlantic TUMOR project has been provided. Based on the decisions taken by the consortium during the latest plenary meeting of the project that took place in Athens on 24 October 2012 - just after the TUMOR project workshop - the plans regarding dissemination through the conference and journal publication channels as well as exploitation from the basic science, technology, clinical and industrial perspectives have been delineated. Both dissemination and exploitation of the TUMOR project outcome are centred around the development of an intercontinental infrastructure which will substantially support and partly automate the creation of complex and multiscale mathematical and computational cancer models by combining modelling modules eventually developed by different modellers or modelling groups. The major long-term goal of the entire endeavour is to translate such models into the clinic so that following a strict clinical adaptation and validation procedure they may support the clinician in the process of treatment optimization in the patient individualized context. The latter is to be achieved through the exploitation of the multiscale personal data of the patient by performing experiments *in silico* (=on the computer) and using the patient's multiscale data. A number of newly European Commission funded projects will partly exploit the European component of the TUMOR project outcomes.

5. ABBREVIATIONS

EU	European Union
FORTH	Foundation for Research and Technology - Hellas
ICCS-NTUA	Institute of Communication and Computer Systems – National Technical University of Athens
MGH	Massachusetts General Hospital
UOXF	University of Oxford
USAAR	University of Saarland
WP	Workspackage