Human Brain Project

Co-funded by the

European Commission

Project Number:	284941	Project Title:	Human Brain Project
Document Title:	Brain Simulation Platform v1 – set-up document		
Document Filename:	SP06_D6.7.2		
Deliverable Number:	D6.7.2		
Deliverable Type:	Report		
Work Package(s):	WP6.1, WP6.2, WP6.3, WP6.4, WP6.5, WP6.6, WP6.7		
Dissemination Level:	PU = Public		
Planned Delivery Date:	M12 / 30 September 2014		
Actual Delivery Date:	M15 / 15 December 2014		

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Abstract:	This Deliverable reports on progress made in the Period M1-M12 in implementing the Specifications set out in Deliverable D6.7.1.
Keywords:	Brain Simulation Platform, Unified Portal, specification, brain builder, molecular simulator, cellular simulator, network simulator, initial brain model

Document Status

Version	Date	Status	Comments
0.1	01 Jul 2014	Draft	Initial Draft from the writing team
1.1	03 Nov 2014	Draft	Jeff Muller - Merged all available contributions.
1.2	07 Nov 2014	Draft	Jeff Muller – Merged latest contributions and updates
1.3	16 Nov 2014	Draft	Felix SCHÜRMANN - Rework of sections 1, 3, 4, 5, 6
1.4	1 Dec 2014	Draft	Katrien VAN LOOK – ready to be sent to the Scientific Writing & Editorial Services Team
1.5	2 Dec 2014	Draft	Final contributions from authors integrated and consolidated.

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Executive Summary

The Brain Simulation Platform (BSP) is one of the six Information and Communications Technology (ICT) Platforms that will be developed by the Human Brain Project (HBP). The BSP and other HBP Platforms will be made accessible to scientific, medical and engineering researchers over the Internet via the HBP Unified Portal (HBP-UP or UP). HBP Subproject 6 is developing both the UP and the BSP.

The purpose of this document is to provide an update on the development of the UP and the BSP, including the Initial Brain Models that will run on the BSP.

The UP will allow seamless interaction with the ICT Platforms and other HBP online resources, while maintaining sufficient simplicity to encourage use by less technically adept Users. All of the tools used throughout the UP will track data provenance and software dependencies to provide pragmatic solutions for reproducible neuroscience. By facilitating the sharing of expertise, data and results, the UP will generate network effects throughout the HBP community and help to maximise the research impact of the entire project.

In addition to reporting progress on the UP, this document summarises progress in BSP high-level software projects:

- A Brain Builder – a software application to establish a data set and activate a series of data-driven algorithms and workflows to reconstruct multi-level brain models at different levels of fidelity.

- A Molecular Simulator – a tool to simulate brain processes at the molecular level.

- A Cellular Simulator – a tool to simulate morphologically detailed neuron models.

- A Network Simulator – a tool to simulate large numbers of simplified neuron models.

The report also summarises progress on Initial Brain Models, and in particular in:

- Molecular and subcellular interaction models

- Molecular-level models of neurons, glia and synapses

- A somatosensory cortex model

- A cerebellum model

- A hippocampus CA1 model

- A basal ganglia model

The document also includes updates on Key Performance Indicators (KPIs) and Function completion for UP and BSP software development, model building, and take-up by the scientific community. The UP and the BSP components will be released to research communities outside the HBP in project Month 30, and in particular to the Partnering Projects envisaged in the Operational Phase, which will be conducted under the aegis of the EU's Horizon 2020 Programme.

1. Introduction

1.1 The Human Brain Project (HBP)

The Human Brain Project (HBP) is a major international scientific research project, involving over 100 academic and corporate entities in more than 20 countries. Funded by the European Commission (EC), the ten-year, EUR 1 billion Project was launched in 2013 with the goal "to build a completely new ICT infrastructure for neuroscience, and for brain-related research in medicine and computing, catalysing a global collaborative effort to understand the human brain and its diseases and ultimately to emulate its computational capabilities."

The fields of neuroscience, medicine and information technology each have important roles to play in addressing this challenge, but the knowledge and data that each is generating have been very fragmented. The HBP is driving integration of these different contributions.

During the Ramp-Up Phase, the HBP will collect strategic data, develop theoretical frameworks, and perform technical work necessary for the development of six Information and Communication Technology (ICT) Platforms during the Operational Phase. The ICT Platforms, offering services to neuroscientists, clinical researchers and technology developers, comprise Neuroinformatics (a data repository, including brain atlases and analysing tools); Brain Simulation (building ICT models and multi-scale simulations of brains and brain components); Medical Informatics (bringing together information on brain diseases); Neuromorphic Computing (ICT that mimics the functioning of the brain); and Neurorobotics (allowing testing of brain models and simulations in virtual environments). A High Performance Computing Platform will support these Platforms.

1.2 HBP Subproject 6: Brain Simulation Platform

It is a central tenet of the HBP strategy that a comprehensive understanding of the brain requires knowledge of structure and function across all levels of brain organisation. This understanding by focusing on any one level. The only approach available today that allows simultaneous study of the brain across all levels is brain simulation using structurally and functionally accurate computer models. Since such an effort involves expertise from neuroscience, computer science, physics and mathematics, constructing such multi-level models requires a massive scientific collaboration. The social Internet and open source software communities have shown that modern Information and Communications Technology (ICT) permits the massive collaborative efforts needed.

Brain simulation within the HBP is the responsibility of Subproject (SP) 6, which is developing the HBP's Brain Simulation Platform (BSP). This is one of six ICT Platforms being developed by the HBP; the others focus on Neuroinformatics, High-Performance Computing, Medical Informatics, Neuromorphic Computing and Neurorobotics.

To facilitate the scientific community's access to the HBP's ICT Platforms and, in a broader sense, to make large-scale collaborations possible in neuroscience, SP6 is also developing the HBP Unified Portal (HBP-UP or simply UP). This web-based collaborative scientific Platform will provide access to the HBP's research, community and administrative activities, as well as its six ICT Platforms. A key tool within the UP of particular relevance for the BSP is the Brain Atlas Embedding Module (BAEM), which will allow applications running on other Platforms to search the Neuroinformatics Platform for modelling and validation data, and a viewer for rich 2D and 3D data.

The UP will be equipped with a layer of powerful social networking functions to allow fluid sharing of data, theories, applications and models prior to publication, while still maintaining proper attribution. This sharing of research, results and expertise will help to accelerate progress in neuroscience, making it easier to achieve the HBP's ambitious goals.

1.3 Purpose of this document

This document outlines progress on the development of the main components described in the Brain Simulation Platform Specification D6.7.1. Where developments since the release of D6.7.1 require changes to the specification or roadmap, these too have been highlighted.

1.4 Structure of this document

The remainder of this chapter provides an SP-level overview, highlighting the SP's main accomplishments in the period M1-M12 and the main issues encountered. Subsequent chapters look at accomplishments and issues within individual components of the SP, as defined in the HBP Brain Simulation Platform Specification (D 6.7.1):

- The HBP Unified Portal (HBP-UP)
- The Brain Simulation Platform (BSP)
- BSP Brain Builder (BB)
- BSP Molecular Simulator (MolSim)
- BSP Cellular Simulator (CellSim)
- BSP Network Simulator (NetSim)
- BSP Initial Brain Models

The Annex presents in tabular form what the Subproject planned to achieve in this period and what it actually achieved, including the Subproject's Scientific Key Performance Indicators (SKPIs).

1.5 Overview of Subproject 6 Achievements

1.5.1 Deliverables

The most significant achievement in this period was submission of SP6's first Deliverable, D6.7.1 – Brain Simulation Platform v1 – specification document. This contains the first formal mention of the HBP Unified Portal (HBP-UP) and sets out the plan for implementation of this major element in HBP strategy, which will provide a single point of access to HBP Platforms and other resources. Because the HBP-UP interfaces closely with all 6 HBP Platforms, it also serves as a useful coordination mechanism between the various Platform teams. D6.7.1 also sets out plans for putting in place the Brain Simulation Platform (BSP) and its various components (reported on separately below). Completion of D6.7.1 provides a framework for development of the HBP-UP and the integration of the BSP and the other 5 HBP Platforms. Deliverable D6.7.1 was delivered to the EC on June 11th 2014. See the Overview of Subproject Problems for further information.

1.5.2 Milestones

The following SP6 Milestones were scheduled and achieved prior to this Deliverable:

- **MS123 - Brain simulation Platform fully specified (scheduled: M6/achieved: M6)** - Version 1 of the Brain Simulation Platform was specified in coordination with all other Subprojects; the requirements were used as input for the Brain Simulation Platform Specification (D6.7.1).

- **MS126 - Requirements for user documentation and support for Brain Simulation Platform; guidelines for establishing alliances (scheduled: M6/achieved: M6)** - A first draft of the documentation specification was reviewed internally by EPFL-BBP. A second draft is in preparation and will be submitted to appropriate HBP Partners when ready. The HBP alliances are listed in D6.7.1 as dependencies between the UP and the six other ICT Platforms. The External Relations Team is establishing alliances external to HBP. Key external alliances involve the Allen Institute for Brain Science, USA and the Britton Chances Center for Biomedical Photonics, China.

- **MS111 - Software application to fit ion channel densities to reproduce any target electrophysiology, v1 (scheduled: M6/achieved: M6)** - A beta version of the EPFL OptimizerFramework software that makes it possible to adjust ion channel densities in neuron models was packaged and released to Partner UNIPV, which is using it to model cells in the cerebellum, and to Partner HUJI, which is using it for human cell modelling. EPFL-BBP is providing bug fixes and direct user support.

- **MS113 – Multi-scale cellular simulator (with a range of neuron models from point neurons to detailed neurons) v1 (scheduled: M12/achieved: M12)** - During the first 12 months, the simulator core of the NEURON simulation environment was extracted from NEURON, providing a stable basis for planned memory footprint reduction, optimisation and software parallelisation to support large scale brain models on future HPC systems. The extracted simulator core has been named CoreNeuron. CoreNeuron can simulate both point neurons and morphologically detailed neurons. CoreNeuron data structures consume a factor of 6-7 less memory than NEURON data structures, run 12% faster on the same test case. CoreNeuron has been incorporated in the benchmark suite for the Precommercial Procurement (PCP) run by SP7.

- **MS119 – First draft model of somatosensory cortex (scheduled: M12/achieved: M12)** - As this Milestone was scheduled before the first internal release of the Brain Simulation Platform (planned for month 18), several steps in the building process used methods that are still in the prototype phase. This experience helped to refine the building processes that will be integrated in the first internal release of the Brain Simulation Platform. Future brain models (e.g. the model of Hippocamus CA1 due in month 24 (MS121) and full neocortex model due in month 30 (MS122)), will use later releases of the Platform. The first draft model of the somatosensory cortex includes 5.5 million point-neurons and around 4 billion synapses. The starting point were Nissl-stain data for mouse from the Allen Brain Institute (ABI), which the ABI has registered to create a reference voxel dataset containing cell body densities and region annotation. The fine grain annotation provided by the Allen Atlas also allowed the identification of layers, making it possible to assign morphological and electrical types from the EPFL detailed model of somatosensory cortex to each cell with the morphological and etype derived from the composition recipe of the detailed somatosensory microcircuit model developed by EPFL (work towards Milestone M122). The predicted microconnectome of the detailed microcircuit model has been used to apply distant-dependent and pathway specific connection probabilities to the entire somatosensory cortex model. To address long-range connectivity between other brain regions and the somatosensory cortex, the BSP team has prototypes the integration of two additional datasets: The Allen AAV tracer injection data set and the mouse DTI dataset from the BIRN initiative.

Two Milestones, MS112 (Software to synthesise cellular morphologies, including projecting axons, v.1) and MS127 (Identification of potential alliances on brain simulation) scheduled for month 12, however, were only partially achieved or rescheduled. See section 1.6.2 for more information.

1.5.3 Work Packages / Components

Some key results of individual work packages:

- **WP6.1 – Data-driven Reconstruction of Brain Models and WP6.5 – Brain Simulation Platform: integration and operation**: The architecture and user specifications of the **brain simulation Platform (BSP)** have been developed and published as a Deliverable (see Deliverable D6.7.1) in coordination with WP6.5. Development has started and first modules have been completed and tested by other Partners, e.g. the software module of Milestone MS111 (Software application to fit ion channel densities to reproduce any target electrophysiology); see section 1.5.2. In addition to the BSP, WP6.1 has collaborated with other Platform building Subprojects (SP5-10) to provide a common framework that unifies access to all 6 HBP Platforms, the **Unified Portal** (see Deliverable D6.7.1). A first working prototype was demonstrated during the first year HBP Summit with great success. The UP provides a unique tool to coordinate and integrate the functionality of the different Platforms and is key to cross-Platform workflows.

- **WP6.2 – Brain Simulation Engines**: This work package aligned its development efforts closely with community-driven roadmaps for the NEST, NEURON, and STEPS simulators, ensuring long-term viability and global community participation. Specific contributions in support of the goals of the HBP included a substantial scale-up of NEST for use on massively parallel computers, a six-fold reduction in the memory footprint of NEURON (see Milestone MS113), and advances in the parallelisation of STEPS. Furthermore, this work package has also collaborated closely with SP7 to extract specifications from NEST and NEURON for future HPC architectures. These specifications were contributed to the Pre-commercial procurement (PCP) run by SP7 in the form of specifications and benchmark suites.

- **WP6.3 Molecular Dynamics Simulation**: Multi-scale molecular dynamics simulation of the activity of adenylyl cyclase (AC) enzyme has been accomplished. Advances in the characterisation of the interactions between the adenylyl cyclase enzyme and the regulatory G-proteins were achieved at different levels of representation. Methodological advances and code performance improvements were addressed. This work represents a prime example of collaboration between multiple HBP groups (KTH, GRS, EPFL, CNRS, HITS, ENS) spanning two work packages WP6.3 (Molecular dynamics simulation) and WP6.4 (Initial Brain Models). Addressing a biological problem of interest to all the groups concerned, has enabled them to prototype a multi-scale approach to molecular modelling.

- **WP6.4 Initial Brain Models: Cellular models:** At the **single cell level**, Partner UNIPV has successfully tested automated modelling of neuronal firing behaviour in cerebellar neurons. This has enabled UNIPV to make substantial progress towards a full cerebellum model for Milestone MS122 (month 30). This work involves close between WP6.1 and WP6.4. Partner HUJI has tested the same automated method on human pyramidal neurons, working in collaboration with Partners from SP2. At the **microcircuit scale**, Partner EPFL achieved a first draft cellular and synaptic reconstruction and simulation of the rodent somatosensory microcircuit with 207 different morpho-electrical cell types (31,000 neurons, 40 million synapses). This work was pursued in WP6.4 (EPFL) and WP6.1 (HUJI) in collaboration with Partners UPM and WMC and is making a major contribution to many workflows in the Brain Simulation

Platform. At the mesocircuit scale, a first draft model of a network-level somatosensory cortex model with 5.5 million point-neurons has been built, fulfilling Milestone MS119. This was achieved by successfully scaling the tool chain for building and simulating cellular-level models to the mesocircuit level (to date we have modelled mesocircuits with 3.1 million detailed-neurons and 5.2 billion synapses). A first draft reconstruction of the cerebellar network of neurons has also been developed. This work is a result of collaboration between researchers of WPs6.1, 6.2 and 6.4.

1.5.4 Contributions

All Partners of this Subproject contributed to the success of the first year.

1.5.5 Changes

There have been no changes in SP6 Partners or work plan. However, the Subproject has requested that two Milestones should be rescheduled (see section 1.6.2); the delay is not expected to have any negative impact on other Deliverables.

1.6 Overview of Subproject 6 Problems

1.6.1 Deliverables

The preparation of the first Deliverable, D6.7.1, was a complex task with many dependencies. This was the first significant delivery by SP6 and coordination between contributors took longer than expected. In particular, reconciling the HBP-UP concept with components planned for the Neuroinformatics Platform and BSP Platforms required a number of iterations. Another challenge was identifying ways to describe BSP's generic modelling strategy and KPI mechanisms that were sufficiently specific about the direction to be followed. Collecting contributions at the right level of detail and addressing feedback from various internal reviews required many revisions of the text were needed. As a result the Deliverable was submitted on June 11th, 2014 instead of on March 30th, 2014, as planned.

1.6.2 Milestones

All achieved Milestones due prior to September 31st 2014 have been reported in section 1.5.2. The only Milestones that were not completely achieved or which required rescheduling were:

- **MS112 Software to synthesise cellular morphologies, including projecting axons, v. 1 (scheduled: M12/rescheduled for: M20)** – This Milestone was mostly completed by month 12 as foreseen; an initial version of the software has been demonstrated and is available. However, the researcher responsible for the projecting axon functionality, has been seriously ill, causing delay.

- **MS127 Identification of potential alliances on brain simulation (scheduled: M12/rescheduled for M20)** – This Milestone is now proposed to be completed in month 20, i.e. after the release of the first version of the Brain Simulation Portal. We believe that having this first release will substantially facilitate discussions for potential alliances.

1.6.3 Work Packages / Components

While communication between specific researchers and Partners has been very efficient, timely follow up across the entirety of SP6 has been a challenge due to the sheer number

of Partners involved. It thus became clear early on that the coordination at the Subproject level cannot only be done by the researchers themselves but also requires administrative support for timely follow up.

1.6.4 Corrective Actions

To improve coordination at the Subproject level, EPFL-BBP has hired a scientific project coordinator, who it shares with SP5. This has had the side effect of improving communication between the two Subprojects, while allowing scientific contributors to focus on their scientific responsibilities.

As far as concerns the delay in Milestone MS112 (see section 1.6.2), we expect to be able to complete the Milestone by month 18 when the researcher concerned is back at work. If this is not possible, other members of the team will complete the work. The delay is not expected to have any negative impact on other Deliverables of the Subproject.

1.7 The Next 6 Months for Subproject 6

The main objective of SP6 during the next 6 months is the delivery of an initial version of the Brain Simulation Platform to the consortium. While individual components of the BSP Platform were already usable by individual researchers and tasks during the first year, the release of the Platforms will make BSP workflows and resources accessible to the HBP across Tasks and institutions. At the same time, the Unified Portal will ensure integration not only within a given Platform but also across all 6 Platforms. The internal release of the Platforms and the Unified Portal will mark the start of ICT-enabled collaborative brain research and will catalyse the progress of many tasks, e.g. work on initial brain models in WP6.4. It will not only facilitate collaboration to build the models but also the use of the models in the other parts of the project, e.g. in the Neurorobotics Platform.

Another objective is to carry on scaling up the brain simulation engines (WP6.2), preparing for future system architectures and the simulation of models of the whole brain. Cellular level models of the whole mouse brain will require a 10x scale-up of the current software. Models on the scale of the human brain will require a 1000x scale-up.

In order to accomplish these objectives, the individual components of the BSP will increase their functionality, scalability and integration; detailed information can be found in the following sections and the phase planning in the appendix.

2. The HBP Unified Portal (HBP-UP)

2.1 HBP-UP: Overall Goals

The UP is a web-based portal intended to provide a single point of access to all collaborators participating HBP research. The UP is designed to catalyse research at all levels of the project by allowing a) instantaneous sharing of data, models, tools, theories, configurations, methods and applications, b) tracking and crediting researchers for their contributions (provenance), c) crowdsourcing mining of the literature, and d) launching collaborative projects.

The UP will also be the primary means by which the HBP shares its scientific and technological advances with the scientific, medical and engineering communities. The UP will therefore provide a Platform for Strategic Partners to present their research projects, form collaborative projects with other members of the Flagship Consortium, and share their progress in advancing or using the HBP ICT Platforms.

To achieve this goal the UP must:

1) Serve both technical users and non-technical users,

2) Perform pervasive provenance tracking,

3) Facilitate simple access to HPC and Neuromorphic computing resources,

4) Facilitate simple access to rich multi-dimensional data sets.

2.2 HBP-UP: Main Achievements

The HBP-UP is one of the primary integration points in all ICT Platform Tasks in the HBP. However, this means that the HBP-UP needs to provide a framework, which the individual Platforms leverage to share their functionality.

In the effort to provide this framework the HBP-UP currently delivers a minimum viable product (MVP) with the services outlined in the figure below. Significant novel functionality has been demonstrated in the deployed and development versions of the Brain Atlas Embedding Module (BAEM).

Specifically the following use cases have been deployed as part of the MVP:

- Low Volume Scientific Data Sharing, Single UP Project with Upload (SP6UP-UC-001)
- Low Volume Scientific Data Sharing, Multi UP Project (SP6UP-UC-002)
- Viewing of Data in HBP-UP (SP6UP-UC-003)
- Collaborative Scientific Analysis (SP6UP-UC-006)
- Scientific Developer Iterative Workflow Development (SP6UP-UC-008)
- Interactive Atlas Exploration (SP6UP-UC-010)

These use cases have been realised with the following high-level architecture:
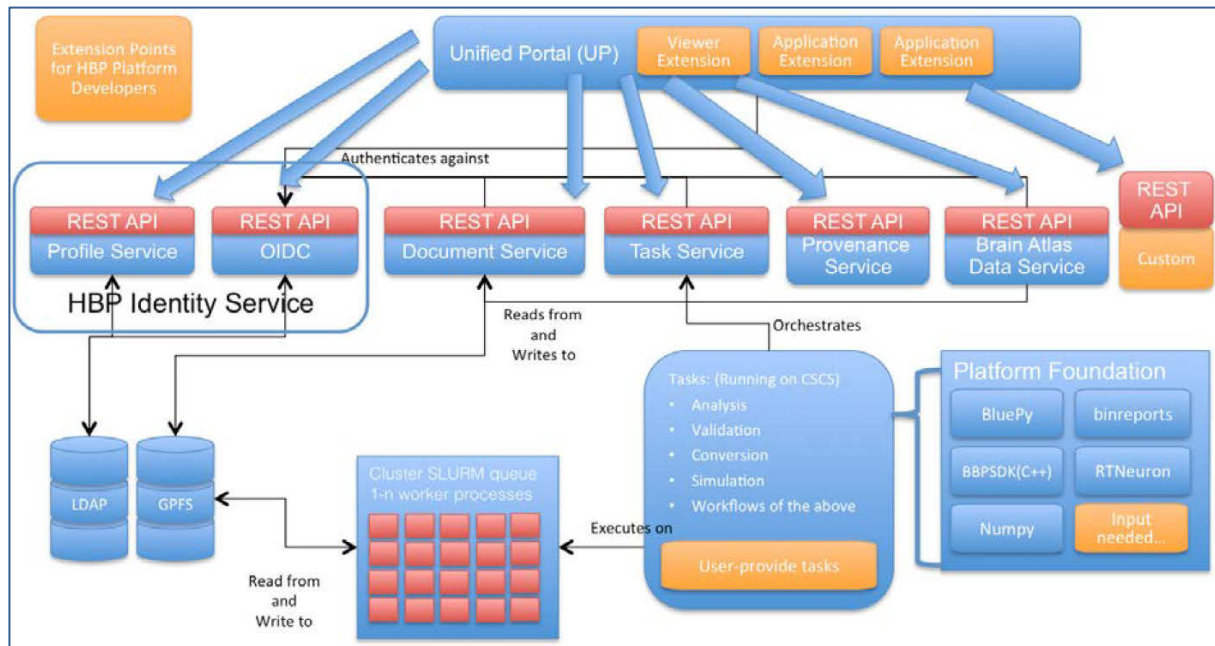
Figure 1: Unified Portal High-level Architecture

2.3 HBP-UP: Main Problems

The main problems for the UP can be summarised as follows:

1) Creation of a modern development (http://en.wikipedia.org/wiki/DevOps) environment to seamlessly deploy new versions from configurations under source control. Solutions:

   a) EPFL-BBP has refocused on the creation of multi-function teams to streamline development of the UP and BSP

   b) EPFL-BBP has hired staff with experience in continuous integration and development to support the approach.

2) Interaction with early prototypes of the HPC Platform. The UP expects a level of uniformity and a simplified user interaction model. This requires work on standardisation of User Management and middleware solutions:

   a) EPFL-BBP has refocused on tighter collaboration between various HPC and UP teams to streamline development of the HPC Prototype Platform.

   b) Incremental adoption of the HPC Platform team's UNICORE middleware is in its early phases.

3) Single sign-on is a complex technical and organisational problem. Evaluation of possible solutions, implementation complexity and coordination with the various dependencies in the HPC Platform and HBP-UP development has delayed integration of this solution into HBP web applications:

   a) Tighter interaction with a vendor of part of the Single Sign-on solution has increased support levels and accelerated the project. The Single Sign-on solution is close to entering production for all HBP users. It will then be incrementally integrated into all web applications and HPC services serving the UP and the Platforms

2.4 HBP-UP: The Next 6 Months

- Working with HBP Platform developers for the creation of Tasks and Viewers.

- Deeper integration with Neuroinformatics Platform efforts and services.

- The multi-site Platform strategy will be finalised in conjunction with the HPC Platform Team

- Polishing for the M18 HBP internal release

- In addition to the initial integration with the Brain Simulation and High Performance Computing Platform, the UP team will address integration with the first versions of the Neuroinformatics, Neuromorphic, Neurorobotics and Medical Informatics Platforms.

3. The Brain Simulation Platform (BSP)

3.1 BSP: Overall Goals

During the Operational Phase, one of the HBP's Strategic Flagship Objectives is to achieve a unifying multi-level understanding of the brain. A Specific Project Objective is to simulate the human brain. The first step towards this goal involves *digital reconstruction and simulation* of the mouse brain, where the multi-level data needed to develop the Brain Simulation Platform is more complete than in the case of the human brain. Later, data from other animals and human brain data will be used to configure the brain building process, as we move towards a first draft reconstruction of the human brain.

During the Ramp-Up Phase, the design of the BSP will seamlessly integrate model building, validation, simulation, visualisation and analysis in a cohesive user-friendly web interface. The brain models are composed of model components at a variety of levels, as well as models of their interactions. Eventually, the BSP aims to model genes, proteins, synapses, cells, microcircuits and brain regions.

Because models are data driven, the BSP is designed to facilitate systematic reconstruction of biologically accurate brain models and their components, using biological data from the Neuroinformatics Platform (NIP). In most cases this biological data needs to be rigorously analysed and algorithmically refined using NIP and BSP tools to extract fundamental parameters for model components.

Finally, the integration of the BSP into the HBP-UP will allow for exchange of data and models between the Neuroinformatics, Brain Simulation, Neurorobotics, HPC, Neuromorphic and ultimately the Medical Informatics Platforms. The same analysis tools that will be used to compare reconstructed models and hardware models will be used to compare high-level models in the Theory Subproject. This will enable more rapid evolution of software models, neurorobotics applications, and neuromorphic hardware models than would otherwise be possible.

3.2 BSP: Main Achievements

The main achievements of the BSP effort have been in the creation of the first examples of functionality integrated into the UP

- Validation representations have been standardised. Initial validations have been deployed as UP Tasks.

- Initial Simulation analysis scripts have been integrated using the standardised UP Task module.

- Platform Foundation packaging for Gnu environment modules has been standardised and is underway for various HBP foundational software libraries used in analysis and validation.

- A major effort has been made to refine the UP architecture to support the planned use cases.

The use cases described in the original plan, are now addressed by components which have been integrated into the UP:

- Validations (SP6BSP-UC-002)

- Compound Model and Model Component Analysis (SP6BSP-UC-003)

Co-funded by the

- Simulation Analysis Tools (SP6BSP-UC-005)

- Collaborative Review Process (SP6BSP-UC-006)

Other accomplishments of the Brain Simulation Platform are described in the following sections dedicated to its specific components: Brain Builder, MolSim, CellSim, and NetSim.

3.3 BSP: Main Problems

There have been no particular problems in the BSP itself, apart from the development issues already discussed in the section on the HBP-UP. It should be noted that some modelling Milestones for Work Package 6.4 (Initial Brain Models) were scheduled before the integration of the relevant components into the BSP and before the release of the BSP to the consortium. This challenge was addressed by selectively sharing individual components with the groups concerned.

3.4 BSP: The Next 6 Months

Over the next 6 months, it is planned to work on the following activities in direct support of the use cases laid out in the BSP specification document (D6.7.1):

- Integration of more libraries and applications into the Platform Foundation, Analysis and Validations Tasks

- Configuration and Launching of Cellular Simulator Tasks on Supercomputers from the UP.

For more details of upcoming developments, see the sections below on specific components of the Brain Simulation Platform For more detailed information on future plans see the expected Functions and the Backlog appendices at the end of this document.

4. BSP: Brain Builder (BB)

4.1 Brain Builder: Overall Goals

The core strategy pursued by the Brain Simulation SP is defined as a data-driven, algorithmic reconstruction of the brain. We call this a Biological Reconstruction Process. We have developed a theoretical framework that provides guidelines for rigorous validation and systematic refinement of reconstructed brain models. The Brain Simulation SP will extend this strategy from reconstructing neurons and microcircuits to reconstructing brain regions, brain systems and the whole brain. Input data for the reconstruction of whole brains down to the molecular level, will include the multi-level structural data on the mouse brain provided by the future HBP Core Project, and the functional data on the mouse provided by the Partnering Projects. The main Deliverable for the first 2.5 years of the Operational Phase will be a first draft reconstruction of the mouse brain The Platform will enable continual community-driven refinement. The multi-level structural data on the human brain provided by the Core Project and the functional data provided by the Partnering Projects in SP2 will provide the human-specific data necessary to apply this strategy to reconstructing the human brain. The main Deliverable for the last five years of the Operational Phase will be a first draft reconstruction of the human brain

The Brain Builder (BB) is the umbrella component for model building functionality in the BSP. The BB is intended to facilitate collaborative model building by integrating model building workflow requirements from around the HBP, and enhancing them for reproducibility, maintainability and usability. In this way, the BSP will evolve as an ecosystem for software and tool development, data sharing, and algorithmic and model development throughout the HBP. As this ecosystem is opened up to the community, data sharing and algorithmic development by experimentalists can be accelerated to reconstruct more accurate models, enrich the models with new data, refine the models as they are collaboratively challenged and validated by biologists, simulate the models and analyse the results, and develop models that can be exploited for the development of novel computing and medical technologies.

4.2 BB: Main Achievements

- A pre-existing version of the morphology workflow (use case SP6BSP-UC-007 - Repair and Diversification of Reconstructed Morphologies) has been integrated and extended to merge synthesised axons for selected m-types. The workflow has been used to produce Somatosensory cellular models with synthesised axons for up to 217,000 cells.

- A prototype version of a morphology synthesis component has been developed (use case SP6BSP-UC-008 - Synthesise Full Cell Morphologies). The component is capable of synthesising neurons and selected glial cell types using a limited set of parameters extracted from biological cells to modulate a set of stochastic growth processes for axons and dendrites.

- For the creation of electrical models of individual cells, an automated fitting component (use case SP6BSP-UC-009 - Create a Complete Cell Model Using Automated Fitting of Conductance Densities) has been developed and released (see MS111 in section 1.5.2). This component has been applied to the generation of neurons from different brain regions including somatosensory cortex, and cerebellum and to the modelling of human pyramidal cells.

- For the building of mesoscale tissue models (Use case SP6BSP-UC-0010 - Distribute Cells and Use this to Create a Point Neuron Model of a Brain Region), a prototype workflow for the integration of information from public reference atlases and spatial registration of whole-brain datasets with data predicted by a morphologically-[detailed microcircuit model has been developed. The component has been used for the creation of a first draft model of somatosensory cortex (see MS119 in section 1.5.2)

- For the building of microcircuit models (use case SP6BSP-UC-012 - Distribute Cells and use this to Create a Detailed Neuron Model of a Rodent Neuronal Microcircuit) a pre-existing workflow from Partner EPFL has been analyzed and modified in preparation for the integration with the Brain Simulation Platform and the UP. In partial fulfillment of MS122, it has been used to create a first draft cellular and synaptic reconstruction of the rodent somatosensory microcircuit with 207 different morpho-electrical cell types (31,000 neurons, 40 million synapses).

- In support of use case SP6BSP-UC-014 (Export a Volume Region of the Cellular Level Model and Add Molecular Level Detail to Produce a Molecular Level Model), the BB team has developed a first prototype workflow that disentangles overlapping morphologies and creates surface meshes for all neurons.

4.3 BB: Main Problems

Problems with particular functions:

- Function 6.1.1.6 - Repair and diversification of reconstructed morphologies
  - Software immaturity and the complexity of the existing workflow have hampered progress.
  - Some development resources have been re-allocated to the Unified Portal to build shared infrastructure for all Platforms.
- Function 6.4.1.4 - Viewing of Data in HBP-UP – Basic Search Integration
  - The system, which will handle this has been taken over by the neuroinformatics Search Service, reducing duplication of effort.
- Function 6.5.1.5 - Data hiding
  - Deprioritised in favour of other functionality
  - Function 6.5.1.6 - Data release
  - Deprioritised in favour of other functionality

4.4 BB: The Next 6 Months

The whole brain builder prototype shows how we can build *atlas-registered models*. The models are built in the same coordinate space as the atlases from which they are derived. This approach provides a natural integration framework for atlas-registered data coming from the Neuroinformatics Platform. It also directly leverages atlases built by SP1 and SP2 and existing bodies of software and algorithms in neuroimaging and computer vision. In this way the draft whole brain models will serve as an integration Platform for further refinements in the models of individual regions and whole brain modelling efforts.

At a high level, the focus of Brain Builder development can be summarised as follows:

- The prototype whole brain workflow will be integrated into the UP as a first test case for the critical interaction between the Neuroinformatics and Brain Simulation Platforms. The teams developing the Unified Portal will work very closely with the Neuroinformatics teams and the developers of the prototype workflow. This is the first step in extending the tools used to build the draft somatosensory model to handle whole brain models.

- The BB will exploit functionality provided by the UP to advance other parts of the brain building workflows.

- The Platform Foundation will be extended with libraries and analysis tools necessary to support brain-building workflows. This support will speed development and integration of brain model analysis, validation and construction, by providing a predictable software Platform to scientists and engineers.

- The BB team will improve software quality in existing Platform Foundation tools in preparation for use by a wider community.

For more detailed plans see the expected Functions or the Backlog appendices of this document.

5. BSP: Molecular Simulator (MolSim)

5.1 MolSim: Overall Goals

The molecular simulator is the simulation engine of the HBP for neuron and synapse models at the molecular level of resolution. The major requirement informing the design process is the ability to represent molecular processes occurring in neural tissue, at relevant resolutions. The focus of the simulator is on detailed geometrical models of synapses and compartmental models of entire neurons and regions of surrounding space. Each of these levels of detail has a different simulation strategy, e.g. reaction-diffusion mathematics for tetrahedral volume meshes; more abstract reaction-only mathematics for well-mixed compartments). In addition to these modelling capabilities, the MolSim component will have to meet performance requirements that allow reasonable turn-around times, and must be able to run on parallel architectures.

5.2 MolSim: Main Achievements

The main achievements can be summarised as follows:

- For prototyping the modelling of biochemically accurate synapses (use case SPBSP-UC-015 – geometrically accurate synapse model with molecular reactions and diffusion), Partner EPFL used the prototypic builder component (see section 4.2), implemented an export to the standard STEPS simulator for simulation, and ran first simulations on serial machines.

- In support of large-reaction diffusion models on parallel HPC systems (use case SPBSP-UC-016 – Molecular Neuron Simulation using MolSim), Partner OIST made major progress on a theoretical framework that allows parallelisation of diffusion calculations, and has implemented first proof-of-concept in software

- For collaborative software development Partners EPFL and OIST introduced a collaboration framework that includes weekly Skype meetings between OIST and EPFL-BBP, a shared private github repository and a test-driven integration workflow.

5.3 MolSim: Main Problems

The main issue was to find a candidate of sufficient quality to hire at Partner EPFL. This was resolved as of June 1st, 2014 when Stuart Yates joined EPFL. The work plan was arranged to minimise the impact of the delay: the focus in the first 8 months was on advancing the theoretical foundations for the parallelisation of the reaction-diffusion framework. Prototype work and software work were only started in the last 4 months of the first year. No negative impact for future Deliverables is expected.

5.4 MolSim: The Next 6 Months

Over the course of the next 6 months we plan to:

- Instantiate MolSim use cases to be supported as part of the HBP and to obtain first time estimates and profiling for those use cases to drive future optimisations and design decisions.

- Review the state of the art for stochastic methods to be used in MolSim and for parallel implementation of these methods.

- Implement a continuous deployment workflow for the release of MolSim on HBP computing Platforms

- Clearly define and document a Python and C++ API for MolSim, supporting better integration in the unified portal

- Investigate existing parallel implementations of MolSim

6. BSP: Cellular Simulator (CellSim)

6.1 CellSim: Overall Goals

The CellSim component is the simulator engine that the HBP uses to simulate large-scale, biophysically realistic neural tissue models, providing observations that relate directly to experimental measurements. As with the other simulators in the BSP, CellSim is subject to two competing requirements. On one hand, the simulator has to provide enough flexibility to allow biophysically detailed modelling of the various processes and objects in the neural tissue. The complexity of the model will depend on the level of detail provided by the available biological configuration data, which will increase over the duration of the project. On the other hand, the CellSim must keep execution times as low as possible while implementing increasingly complex large-scale tissue models. This will require optimisation for memory consumption and for scalable performance on massively parallel supercomputing architectures.

6.2 CellSim: Main Achievements

The main achievements of the first year can be summarised as follows:

- As part of the microcircuit work of Partner EPFL, work on the cellular simulator for use case SPBSP-UC-017 (Simulation of a Microcircuit with Biophysically Realistic Neurons) has been successfully completed. The functionality has been made available to Partner UNIPV for modelling of the cerebellum. Additional functionality has been prototyped to support gap junctions and plasticity.

- The performance and strong scaling capabilities of the NEURON simulator have been analysed, improved and tested so that the simulator can support rapid testing of multiple models (use case SPBSP-UC-018 – Multi-Parameter Exploration of Medium sized networks with biophysically detailed neurons),

- Several steps have been taken in preparation for the extension of CellSim capabilities to entire brain regions (use case SPBSP-UC-019 – Full-Scale Simulation of an Entire Brain Region with Biophysically Realistic Neurons),

  – Successful implementation of coreNeuron, a reduced version of NEURON which is able to reproduce the same results as NEURON using 7 times less memory

  – First simulation of 3.1 million morphologically detailed neurons using coreNeuron on 2 racks of the IBM Blue Gene/Q

  – Successful support of multi-scale CellSim with point neuron and morphologically detailed neuron models (Milestone 113) using both regular NEURON and coreNeuron.

  – Implementation of a continuous integration system supporting the review and automatic testing of software patches on any pull request

6.3 CellSim: Main Problems

There were no major problems during the first year. The main challenge of bringing the simulator core to a state that allows future scaling has been accomplished.

6.4 CellSim: The Next 6 Months

Over the next 6 months, we plan to:

- Further reduce the memory footprint of the application by cleaning up the software and investigating the use of single precision variables for some fields.

- Fully document and implement all use cases to be supported by HBP.

- Implement check point/restart and model duplication functionalities to better support longer and larger use cases.

- Implement optimisations to support simulation of larger models (10-20 million neurons) on EPFL-CSCS and JSC supercomputers,.

- Fully deploy the software on HBP computing facilities and integrate it with the Platform Foundation and the Unified Portal.

7. BSP: Network Simulator (NetSim)

7.1 NetSim: Overall Goals

The network simulator is simulation engine the HBP uses for network models at the level of resolution of neurons and synapses. The major requirement informing the design is the need to represent parts of the brain at this level of resolution without downscaling. This means that brain networks can be represented at natural size with all their neurons and synapses. The focus of the simulator is on large networks of simple model neurons. Neurons are typically abstracted to point models, each of which is described by a set of coupled differential equations for a few dynamic variables. The simulator meets the memory requirements arising from the representation of the natural number of synapses per neuron by distributing the neurons over the nodes of a parallel computer. Connectivity information is stored only locally, on the machine on which the receiving neuron resides. The parallelisation of the data structures and algorithms is hidden from the User, enabling the same network simulation scripts to be executed on a laptop and on a supercomputer, provided the network size is adapted accordingly. A more detailed description of the Network Simulator can be found in the SP6 Platform Specification (D6.7.1).

Starting from the list of use cases in the Platform Specification, we developed lists of functional and non-functional requirements (FR and NFR, respectively) for the Network Simulator NEST. These lists are contained in section 6.2 of the Platform Specification.

By comparing the functionality of the current prototype version of the NEST simulation kernel for contemporary supercomputers (Kunkel et al., 2014, doi:10.3389/fninf.2014.00078) with the set of FR and NFR, we identified a list of programming tasks for the Ramp-up Phase.

To manage and track the progress, we are using NEST's internal issue tracker, assigning tickets for required programming tasks to tickets for requirements and requirement tickets to Milestones. This means that each requirement ticket is a meta-ticket that is declared fixed when all tickets it depends on are also fixed. For a mapping between HBP requirements and NEST ticket numbers, see Annex D; for roadmap planning, see the Milestones in Annex A.

7.2 NetSim: Main Achievements

Since the start of the Human Brain Project in October 2013, we have worked mainly on improving NEST connection routines (SPBSP-FR-023) and parallelisation (NetSim NFR5). Specifically, we purged old versions of the connection routines from the code base and cleaned up the existing functions (SPBSP-FR-023-01, SPBSP-FR-023-07, SPBSP-FR-023-08), made the user interface for bulk connection routines more flexible with respect to the input they accept (SPBSP-FR-023-04), allowing randomised initialisation of connection parameters like weight, delay, time constants etc. (SPBSP-FR-023-06), and adding unit tests for uniform and lognormal random deviate generators (SPBSP-FR-023-09). We also removed the Pthreads interface in favour of a more general solution based on OpenMP (SPBSP-NS-NFR5-01, SPBSP-NS-NFR5-02) and made all connection routines run thread-parallel (SPBSP-FR-023-05). This means that NFR5 is complete and SPBSP-FR-023 is almost complete. Most of this work was made public in the 2.4.0 release of NEST on June 13, 2014.

In addition, we have executed all unit tests and examples required to ensure that requirements for non-functional Interfaces (NFR3) and Efficiency (NFR4) are met. The same procedure was carried out for the correlation recording device (SPBSP-FR-020).The

parallelisation of the connection routines provided noticeable advantages compared to the previous implementation, due to a reduction of overhead and increased modularity and maintainability of code.

The main work during this first phase was carried out by Hannah Bos, Jochen Martin Eppler, and Tammo Ippen in JÜLICH, and Hans Ekkehard Plesser at NMBU (names in alphabetical order).

7.3 NetSim: Main Problems

There were no major problems during the past year

7.4 NetSim: The Next 6 Months

Following our roadmap planning (see Annex A), we will focus on finishing the connection routines for unstructured and structured networks and fix the remaining problems with neuron and synapse models. We do not expect any major obstacles during this period.

8. BSP: Initial Brain Models

8.1 Introduction

One of the primary goals of WP6.4 (Initial Brain Models) is to define the initial data sets for reconstructing and validating reconstructions at each level of brain organisation, test the reconstruction process, guide and refine the reconstruction algorithms, and establish a core group of "early adopters" for the Brain Builder. To achieve these goals, WP6.4 will use the Brain Builder to develop initial brain models at the molecular-level (neurons, glial and vascular), cellular-level (neurons from different brain regions), meso-level (somatosensory cortex, hippocampus CA1, cerebellum) and macro-level (hippocampus, basal ganglia and neocortex). The cellular and micro-levels have been established previously for the somatosensory cortex and will be improved as implicit components of the meso- and macro-level reconstructions. WP6.3 is closely linked to molecular level tasks in WP6.4. Parameter values for protein-protein interactions, binding affinities, reaction kinetics, diffusion, etc. will be predicted based on molecular dynamics simulations spanning several scales.

WP6.4 is interacting closely with SP1, SP2 and SP5 to satisfy the data needs of initial brain models and is working with SP1 and SP2 to define a standardised data set to seed the initial models. A key goal is to establish a framework to integrate specific data generated in the Core Project, Partnering Projects, and general data from European and International Collaborations. Work is in progress with SP5 to establish techniques for organising reconstruction and validation data in generic ways that can be consumed automatically by BSP algorithms. These techniques will be refined throughout the Operational phase and will help to make data available to the HBP and the community in a pragmatic use-case driven manner.

WP6.4's various Tasks and modelling Milestones are synchronised with BSP development efforts in Work Packages 6.1, 6.2, and 6.5. In this way, Platform development is guided by modelling, and modelling can leverage and populate the emerging Brain Simulation Platform. WP6.4 provides Use Cases and beta testing for BSP and UP functionality. In the process, it will populate the UP with exemplar workflows that will help UP Users to understand the steps involved in building biologically accurate brain models and relevant data requirements and principles. WP6.4 activities are intended to encourage community adoption of the BSP and the UP.

To extend network, cellular and subcellular modelling efforts to the molecular scale, WP6.3 is developing a multi-scale molecular dynamics based strategy to access biochemical and biophysical data of relevance for the mathematical modelling of molecular networks. Once models are built and validated, WP6.4 will use the BSP to configure virtual experiments that run on one of the simulator systems provided by the Platform. The BSP will include analysis packages developed by various HBP groups that will be usable through the web interface. The results of the simulations and analysis will be shared through the HBP-UP.

8.2 Initial Brain Models: Main Achievements

8.2.1 T6.1.3 - Automated Modelling of the electrical behaviour of single neurons

This Task is developing and refining automated methods for building conductance-based models (CBMs) that faithfully replicate the firing characteristics of any neuron type in any

brain region, from mouse to human. The models are tightly constrained by available experimental data including data on cell morphology, electrophysiology, ion-channel kinetics and, where possible, gene expression. Models are continuously refined using results from validation experiments. The modelling framework is an expansion of the Hodgkin and Huxley (1952) formalism, combined novel optimisation techniques (e.g., the multiple objective optimisation, MOO) (Druckman et al., 2008). We have already started to develop new methods for the objective classification of neurons into electrical and morphological types.

8.2.2 Molecular-level modelling - WP6.3 and T6.4.1

T6.4.1 Task has built and constrained ordinary differential equation (ODE)-based signalling models for a variety of G-protein coupled receptor (GPCR) cascades activated by different neuromodulators. In parallel, WP6.3 has developed multi-scale molecular dynamics methods to quantitatively predict the protein-protein interactions and enzymatic activity involved in such models. Currently most of the data used to constrain parameter values come from neurons in the striatum, a region in which dopaminergic and cholinergic systems are well represented, playing a major role in behaviours as well-established as Pavlovian learning and as pervasive as drug addiction. Phenotypes from cortex and hippocampus have also been used to build and constrain models.

One specific case of a neuromodulatory pattern, the processing of concomitant dopamine and acetylcholine transients by GPCRs, is being investigated by both T6.4.1 and WP6.3. Specifically, WP6.3 is studying the mechanisms by which the G proteins associated with Dopamine/D1R and Acetylcholine/M4R interact with Adenylyl Cyclase 5. The results from this work will be used to further constrain the ODE models built in T6.4.1. The different Tasks in WP6.3 are using different approaches to this problem, which will allow the generation of kinetic and thermodynamic parameters. The Task is also pursuing methodological advances and improvements in the performance of molecular dynamics codes.

Some constrained ODE based models have been already delivered for use in HBP databases and the exploration of algorithmic reconstruction schemes. T6.4.1 postdoctoral fellow, Omar Gutierrez Arenas, has built original models that generate biologically meaningful dynamic behaviours including the behaviour under study in WP6.3. In a related effort, Anu Nair, PhD student, has manually constrained the model and worked with WP6.3 to further explore its dynamics.

One of the main lessons learned in these efforts is that putting the emphasis on the algorithmic nature of the model construction process requires a change in mind-set and takes some time. Part of the difficulty comes from accepting a reduction in model accuracy compared to manual methods that are time consuming and hard to automate..

T6.4.1 has met regularly with Dan Keller at HBP-EPFL to check focus and exchange ideas. So far T6.4.1, has produced one original publication. Another, involving interaction with WP6.3, is in preparation.

8.2.3 Molecular-level models of synaptic plasticity, homeostasis and neuromodulation - T6.4.2

Task 6.4.2 has built models of synaptic plasticity in inhibitory synapses, based on the structural bistability of GABA receptors and the Gephyrin scaffold. We have also developed a framework for equilibrium and non-equilibrium simulations of synaptic components, starting with simulations of scaffold components in the inhibitory synapses. A framework for n-particle simulations, developed by T6.4.2 has been incorporated in the surface parametrisation model.

T6.4.2 has also built a model of the key components in inhibitory synapses, focusing on the kinetics and spatial distribution of molecular components. The focus is on situations: 1) with excitatory synapses on spines and inhibitory synapses on dendritic stems; 2) where dendritic spines contain both inhibitory and excitatory synapses. The last case is likely to provide unique insights into the "sub-integrative" properties of spines, which allow them to act as coincidence detectors. The results will allows us to build a model of inhibitory synapses that other groups can use. It will also give us information about missing components that may be needed to further improve simulations. Biweekly meetings with other groups in WP6.4, have focused on understanding how to incorporate the models into the framework for the modulation of synaptic conductance in BBP simulations. The goal is to provide a testable model that accounts for the regulation of inhibitory receptor numbers, and therefore synaptic strength, depending on neuronal and excitatory activity.

8.2.4 Molecular-level models of NGV coupling - T6.4.3

The 6.4.3 Task aims to model the interactions of neurons, glia, and vasculature. To this end, we have adapted a model of glia metabolism to the neocortical microcircuit simulation. 50 micron voxels are mapped onto the cortical volume, and the model of glial metabolism is run in each voxel resulting in e.g. lactate production. The simulation tracks the concentration of extracellular ions and metabolites, and allows them to diffuse within the brain. We observe spatially different signals of metabolites in response to different stimulation paradigms. The simulation infrastructure can form the basis for future work linking glial activity back to synaptic modulation and changes in blood flow.

8.2.5 Cellular-level models of neural microcircuits - T6.4.4

In this period, T6.4.4 identified relevant cell types and collected other anatomical data to be included in the hippocampus CA1 microcircuit model. Discussion of the categorisation criteria for neurons has allowed the development of a first draft ontology for CA1. T6.4.4 subsequently used the classification criteria to categorise a large collection of electrically recorded, stained neurons and to identify "typical" examples for each cell type.

An agreement was reached about the set of reconstructions and electrical traces needed for the model and plans for the next phases in the work, established accordingly. Examples of pyramidal cells were selected and reconstructed in 3D (Neurolucida). This Task required the retrieval of archived data, originally stored in a range of now obsolete media and conversion to a more accessible format. This work was performed in collaboration with EPFL-HBP. At UCL-HBP local group meetings, neurons from the archive were assessed for quality and completeness of associated data and categorised for cell class. Planning was facilitated by regular teleconferences with EPFL-HBP. Contributors to this work include Audrey Mercer, Joanne Falck, Sigrun Lange, from UCL-HBP and Armando Romani, Martin Telefont, and Eilif Muller from EPFL-HBP

In parallel with the construction of the hippocampal model, EPFL delivered a first draft cellular and synaptic reconstruction and simulation of the rodent somatosensory microcircuit with 207 different morpho-electrical cell types (31,000 neurons, 40 million synapses simulated with the improved Neuron simulator engine). The construction of this model, which has its roots in the BBP-EPFL, allowed the development of crucial workflows for the Brain Simulation Platform. A scaled up first draft model of a network-level somatosensory cortex model with 5.5 million point-neurons has also been built (MS119) and simulated using the improved Nest simulator.

8.2.6 Cellular-level models of brain regions - T6.4.5

During the first year of activity (M1-M12), the team at UNIPV implemented cerebellar neuron models using the automated cell builder software (MS111) and connected them into

a cerebellar granular layer network. This work provides the first proof that the HBP modelling framework can be used outside the cerebral cortex. The new models include granule cells and Golgi cells and exploit work carried out in the initial months of HBP, in which canonical models for these neurons were reproduced using standard technologies. The new models were generated in collaboration with EPFL, using optimisation protocols based on genetic algorithms (I.Segev, WP6.1, 6.2) and exploiting EPFL computing capabilities. A cerebellar network of 400000 neurons was then simulated on the HBP Development supercomputer. This took just 4 months, demonstrating the effectiveness of the HBP modelling strategy. Now we are proceeding toward the completion of the cerebellar network model, the refinement of neuronal models, and the incorporation of new features into the automated cell builder software.

The work was performed by Egidio D'Angelo (PI), Stefano Masoli (full-time), Martina Rizza (full time) with the support of Sergio Solinas (half-time), Sathyaa Subramanyam (half-time) and Stefano Casali (half-time) in collaboration with EPFL (Werner Van Geit, Eilif Muller). The project is now ahead of schedule.

8.2.7 Cellular-level models of whole brain - T6.4.6

Task 6.4.6 is developing a full-scale model of basal ganglia (BG). The big picture includes the striatum, including its matrix and patch compartments, cortical and thalamic synaptic inputs, the pallidum, habenula, substantia nigra and the subthalamic nucleus. The model will allow the implementation of direct, indirect and hyperdirect pathways and of neuromodulatory, primarily dopaminergic circuits. Current work is focusing on the basic striatal circuit of the matrix compartment.

During the first year, T6.4.6 identified the cell types to be included in the model and developed compartmental models of two classes of projection medium spiny neurons with D1 and D2 dopamine receptors, and fast-spiking interneurons. The models were built and implemented in GENESIS and NEURON in preparation for porting to the HBP UP. An extensive literature search combined with model simulations and verification, made it possible to specify connectivity within the basic striatal circuit.

Eilif Muller and Werner Van Geit (EPFL) planned the Task and adopted the HBP workflow. Interactions with WP6.4.5 and WP6.1.3 (Egidio d'Angelo, Idan Segev et al.), enabled preparatory work on cell model optimisations. This work is proceeding in close collaboration with T6.4.1 (Omar Gutierrez Arenas and Jeanette Hellgren Kotaleski) who face similar problems on another, sub-cellular, level and also rely on cell simulations.

8.3 Initial Brain Models: Main Problems

8.3.1 Common Problems for Subcellular and Molecular Models

The problems encountered vary by Task but some limitations are common to all models. In no single case is there enough available data to fully constrain models. This implies that at this stage in the work, models are over- parameterised. For example, we do not currently have enough information about the total amounts and localisation of proteins, or detailed channel composition. Still, broadly accepted concepts and approximations allow the reconstruction process to proceed. A second problem is high methodological heterogeneity in the data gathered from the literature. Resolving this problem will require an ontology to structure the data and guide weighting during model optimisation. These issues highlight the crucial role of the Neuroinformatics Platform, both with regard to ontologies and actual data. To speed up the search for solutions, WP6.4 groups have started to interact closely with SP1 and SP5, ensuring that urgently needed data is given high priority.

8.3.2 T6.1.3 - Automated Modelling of the electrical behaviour of single neurons

The main challenge faced by T6.1.3 has been the development of classification methodologies, which make sense in the light of studies of human cells been studied over the last year. This work will continue in the coming months.

8.3.3 WP6.3 and T6.4.1 - Molecular-level models of neurons, glia and synapses

The application to optimise cellular models (M111) has not yet been generalised for optimisation of intracellular signalling models, making it necessary to optimise these models manually. WP6.3 also found that the structure of the test system under study (the AC enzyme) has only been partially characterised experimentally. The lack of high-resolution crystal structures makes it to predict relevant conformations and conformational transitions upon binding. WP6.3 is addressing this issue, using a range of techniques including homology modelling, normal mode analysis, coarse-grained MD and enhanced sampling MD.

8.3.4 T6.4.2 - Molecular-level models of synaptic plasticity, homeostatic mechanisms and neuromodulation

Optimisation of the important pathways involved in the bulk concentration of molecular components for inhibitory synapses and its relation to clustering of the scaffold still needs to be understood and/or performed. T6.4.2 is trying to approach this issue experimentally.

8.3.5 T6.4.3 Molecular models of neuro-vascular-glial coupling

Synchronisation between the electrical simulations and molecular simulations involves a trade-off between the accuracy of the simulation and the frequency of synchronisation. Avoiding duplication between models and facilitating interchange with other groups requires a common scheme for representing reactions.

8.3.6 T6.4.4 Cellular models of neural microcircuits

No particular problems were encountered during this first phase of the work. Everything proceeded as planned.

8.3.7 T6.4.5 Cellular models of brain regions

There are no real problems with this Task. On the contrary, using and extending the software from Task T6.1.3 has been provided T6.4.5 with new insights that can contribute to the modelling of other brain regions such as the hippocampus.

T6.4.6 Cellular-level models of the whole brain

One of the problems during the initial phase was the transition to a new set of simulation tools based on NEURON and Python. In the future, this kind of issue will be alleviated through the adoption of a standard user interface within the Platform. Due to the lack of transcriptomes for the main cell types, it will be a big challenge to specify electrophysiological phenotype in BG. However, this situation is expected to improve in parallel with the development of the NI Platform and the incorporation of new experimental data providing the required information.

8.4 Initial Brain Models: The Next 6 Months

8.4.1 T6.1.3 An automated method for modelling the electrical diversity of neurons

T6.1.3 is applying new classification methods to a data set of cortical neurons from Human temporal cortex. The classification of Human pyramidal cells into m-types, will require the use of new spike features (e.g., depth of spike after-hyperpolarisation) unique to Human spikes, as well as statistical methods (e.g., principle component analysis, discriminant functional analysis). We expect that electrical models of the spiking activity of human cells, and the classification of Human cortical cells will be completed in the next 6 months.

8.4.2 WP6.3 and T6.4.1 - Molecular-level models of neurons, glia and synapses

On the molecular scale (WP6.3), work continues on the development of methods for multi-scale molecular dynamics and the modelling of protein-protein interactions involved in signal transduction. In parallel T6.4.1 is computing binding constants for morphine and morphine derivatives and the opioid receptor, the focus of M116 (due on M18).

The main objective for the next 6 months is to implement automated fitting of intracellular signalling models to available phenotypic data, not only as independent formalisms but also in cellular models. T6.4.1 will use a approach similar to the approach used to fit biophysically detailed neuron models: total amounts of conserved moieties will be optimised with a genetic algorithm to reproduce parameterised phenotypic data. This will represent a major contribution to the M120 Milestone. Most of the preliminaries have been completed. However, the structures of the two problems may not be the same and this could pose unexpected challenges.

8.4.3 T6.4.2 - Molecular-level models of synaptic plasticity, homeostatic mechanisms and neuromodulation

During the next six months, T6.4.2 will be performing statistical significant simulations. To this end, we will improve the design of the procedure linking theoretical and experimental data. We will use the procedure to simulate realistic morphological spine-dendritic surfaces. To test performance, we will include bulk distribution within the framework of the running simulation.

8.4.4 T6.4.3 - Molecular models of neuro-vascular-glial coupling

During the next six months, the glial cell model will be expanded through the generation of synthetic astrocyte morphologies and placement of these cells within the circuit. T6.4.3 will also integrate improved models of calcium and glycogen modulation in the glia. We are also studying the best way of linking glia activity back to synaptic activity in the circuit, and have opened a dialogue with Marja-Leena Linne in SP1 on this issue.

8.4.5 T6.4.4 - Cellular models of neural microcircuits

To create the backbone for the first draft of model and test its compatibility with the Platform, T6.4.4 will build a skeleton model of the CA1 microcircuit using coarse anatomical constraints. After that, development will start on the first draft of the CA1 microcircuit, using cellular models obtained from single neurons. In the next phases, the model will be iteratively refined as additional neurons are added to the database.

During the next six months, data for additional ten hippocampal CA1 interneurons classes will be retrieved from archived material, analysed and made available to the EPFL-HBP team in an appropriate format. Attempts will be made to provide exemplars of most cell classes already identified. A first demo version of a data ontology will be created and used to integrate synapse physiology data from publications.

8.4.6 T6.4.5 - Cellular models of brain regions

Preliminaries have been completed and the work can now proceed. As explained above, major issues have been solved and modelling in the HBP framework has successfully begun. Now it is necessary to improve the neuron modelling Platform, the network modelling Platform, and the informatics system. Simulations of physiological problems using the network should start soon.

The plans for the next three months are the following. First of all, we will extend single neuron modelling in the automated cell builder software (MS111). We will then complete the granule cell model, generating families of solutions that we will compare to real data and run optimisation tests on Purkinje cells (PC) and unipolar brush cells (UBC). These are among the most complex neurons in the brain. PCs present specific issues for parameter optimisation due to their multi-state function, the complexity of the constraints to be respected, and complex patterns of current transmission between dendritic synaptic inputs and soma. UBCs have intracellular signalling cascades regulating ionic channels that need to be coupled to synaptic transmission.

In other work, we will plan how to introduce synaptic inputs into the optimisation paradigm and extend simulations of the cerebellar network. We will also define appropriate strategies to generate the network, which may not be identical to the strategies used to generate the neocortical microcircuit. Exchanges of personnel with EPFL will allow us to improve competencies in the management of network simulations data sharing and analysis. A meeting with Platform developers is planned. This will give UNIPV the capability to launch simulations directly, and allow them to manage stimulus patterns for the network simulations and for synaptic inputs in the automated cell builder software (MS111).

In 2015 it is planned to use synaptic inputs as stimuli for PC and UBC optimisation and to fully develop the cerebellar network. To do this, it will be necessary to reconstruct stellate and basket cells (SC and BC) and to define a morphology synthesis strategy for glomeruli and their connections (in particular for granule cells). The end result will be a reconstructed cerebellar cortical network running in the NEURON simulator.

8.4.7 T6.4.6 - Cellular-level models of the whole brain

Some preparation is still needed before it is possible to reconstruct a model of basal ganglia (BG), using the Brain Builder. Due to the scarcity of detailed morphological reconstructions of the main neuron types present in the striatum (medium spiny neurons; MSNs)s, it will be necessary to collect available data. The automated cell builder software (MS111) will be used to model MSNs. This work will be followed by modelling of striatal neurons' electrophysiological properties. An interesting collaboration with R6.4.1 on neuromodulation will investigate the possibility of using the same optimisation procedures to study interactions between cellular and sub-cellular dynamics.

9. Scientific Coordination

9.1 Scientific Coordination: Internal Meetings

Date	Description	Location	Participants	Comments
08/10/2013 09/10/2013	SP6	EPFL, Switzerland	Meeting at the 1st HBP Summit	Attendees unrecorded
11/10/2013	WP6.3 & WP6.4	EPFL, Switzerland	Paolo Carloni (GRS), Jeanette Hellgren Kotaleski (KTH), Rebecca Wade (HITS), Richard Lavery (CNRS), Ursula Roethlisberger (EPFL), Pietro Vidossich (GRS), Jens Dreyer (GRS), Emiliano Ippoliti (GRS), Juliette Martin (CNRS)	External contacts that were present: Modesto Orozco, Giulia Rossetti (GRS), Frank Noé (GRS)
08/11/2013	T6.4.1-6.4.3	Skype	Daniel Keller (EPFL), Jeanette Hellgren Kotaleski (KTH), Antoine Triller (ENS), Omar Gutierrez Arenas (KTH), Leandro Almeida (ENS)	
12/11/2013	WP6.3 & WP6.4	Skype	Paolo Carloni (GRS), Rebecca Wade (HITS), Richard Lavery (CNRS), Jeanette Hellgren Kotaleski (KTH), Juliette Martin (CNRS)	
22/11/2013	T6.4.1-6.4.3	Skype	Daniel Keller (EPFL), Jeanette Hellgren Kotaleski (KTH), Omar Gutierrez Arenas (KTH), Leandro Almeida (ENS)	
29/11/2013	T6.3.2	Skype	Paolo Carloni (GRS), Ursula Roethlisberger (EPFL), Pietro Vidossich (GRS), Siri van Keulen (EPFL)	
10/12/2013	WP6.3	HITS, Germany	Rebecca Wade (HITS), Paolo Carloni (GRS)	
12/12/2013	WP6.3	GRS, Germany	Paolo Carloni (GRS), Rebecca Wade (HITS)	
13/12/2013	T6.4.1-6.4.3	Skype		Attendees unrecorded
10/01/2014	T6.4.1-6.4.3	Skype		Attendees unrecorded
24/01/2014	T6.4.1-6.4.3	Skype		Attendees unrecorded
29/01/2014	T6.3.2	Skype	Pietro Vidossich (GRS), Paolo Carloni (GRS), Ursula Roethlisberger (EPFL), Siri van Keulen (EPFL), Emiliano Ippoliti (GRS)	
07/02/2014	T6.4.1-6.4.3	Skype		Attendees unrecorded
27/02/2014	SP6	Video conference		Attendees unrecorded
14/03/2014	T6.4.1-6.4.3	Skype		Attendees unrecorded

Date	Description	Location	Participants	Comments
17/03/2014	WP6.3 & WP6.4	Skype	Pietro Vidossich (GRS), Paolo Carloni (GRS), Rebecca Wade (HITS), Richard Lavery (CNRS), Juliette Martin (CNRS), Jeanette Hellgren Kotaleski (KTH)	
24/03/2014	SP6	Video conference		Attendees unrecorded
28/03/2014	T6.4.1-6.4.3	Skype		Attendees unrecorded
02/04/2014	T6.3.1 & T6.3.2	CNRS, France	Pietro Vidossich (GRS), Richard Lavery (CNRS), Juliette Martin (CNRS), Siri van Keulen (EPFL), Elisa Frezza (CNRS), Nicoletta Ceres (CNRS)	
11/04/2014	T6.4.1-6.4.3	Skype		Attendees unrecorded
25/04/2014	T6.4.1-6.4.3	Skype	Jeanette Hellgren Kotaleski (KTH), Daniel Keller (EPFL), Leandro Almeida (ENS), Marja-Leena Linne (TUT), Michele Migliore (CNR)	
05/05/2014	SP6	Video conference	Jeanette Hellgren Kotaleski (KTH), Sten Grillner (KI), Markus Diesmann (JUELICH), Jochen Martin Eppler (JUELICH), Pietro Vidossich (GRS), Leandro Almeida (ENS), Michael Hines (YALE), Jeffrey Muller (EPFL), Eilif Muller (EPFL), Fabien Delalondre (EPFL), Daniel Keller (EPFL), Felix Schürmann (EPFL), Katrien Van Look (EPFL)	
09/05/2014	T6.4.1-6.4.3	Skype		Attendees unrecorded
23/05/2014	T6.4.1-6.4.3	Skype	Jeanette Hellgren Kotaleski (KTH), Daniel Keller (EPFL), Leandro Almeida (ENS), Michele Migliore (CNR), Omar Gutierrez Arenas (KTH)	
02/06/2014	SP6	Video conference	Henry Markram (EPFL), Jeanette Hellgren Kotaleski (KTH), Sten Grillner (KI), Markus Diesmann (JUELICH), Jochen Martin Eppler (JUELICH), Idan Segev (HUJI), Martina Schmalholz (UHEI; STO), Pietro Vidossich (GRS), Michael Hines (YALE), Rebecca Wade (HITS), Neil Bruce (HITS), Daniel Keller (EPFL), Felix Schürmann (EPFL), Jeffrey Muller (EPFL), Eilif Muller (EPFL), Fabien Delalondre (EPFL), Katrien Van Look (EPFL)	

Date	Description	Location	Participants	Comments
04/06/2014	T6.3.2	Skype	Pietro Vidossich (GRS), Paolo Carloni (GRS), Siri van Keulen (EPFL), Ursula Roethlisberger (EPFL)	
06/06/2014	T6.3.3 & T6.7.1	HITS, Germany	Rebecca Wade (HITS), Felix Schürmann (EPFL), Neil Bruce (HITS)	
06/06/2014	WP6.3 & WP6.4	Skype	Pietro Vidossich (GRS), Paolo Carloni (GRS), Rebecca Wade (HITS), Neil Bruce (HITS), Richard Lavery (CNRS), Elisa Frezza (CNRS), Nicoletta Ceres (CNRS), Juliette Martin (CNRS), Jeanette Hellgren Kotaleski (KTH)-	
13/06/2014	T6.4.1-6.4.3	Skype		Attendees unrecorded
27/06/2014	WP6.3	Barcelona, Spain	Pietro Vidossich (GRS), Paolo Carloni (GRS), Rebecca Wade (HITS), Neil Bruce (HITS), Richard Lavery (CNRS), Juliette Martin (CNRS), Elisa Frezza (CNRS), Nicoletta Ceres (CNRS), Ursula Roethlisberger (EPFL), Siri van Keulen (EPFL)	
04/07/2014	T6.4.1-6.4.3	Skype		Attendees unrecorded
07/07/2014	SP6	Video conference	Michael Hines (YALE), Markus Diesmann (JUELICH), Jochen Martin Eppler (JUELICH), Neil Bruce (HITS), Egidio D'Angelo (UNIPV), Daniel Keller (EPFL), Felix Schürmann (EPFL), Eilif Muller (EPFL), Fabien Delalondre (EPFL), Katrien Van Look (EPFL)	Since many Partners were attending the FENS conference in Milan, the meeting was kept short and re-scheduled for the following week.
14/07/2014	SP6	Video conference	Jeanette Hellgren Kotaleski (KTH), Henry Markram (EPFL), Egidio D'Angelo (UNIPV), Marc-Oliver Gewaltig (EPFL), Martina Schmalholz (UHEI; STO), Michael Hines (YALE), Neil Bruce (HITS), Jochen Martin Eppler (JUELICH), Markus Diesmann (JUELICH), Eilif Muller (EPFL), Jeffrey Muller (EPFL), Felix Schürmann (EPFL), Daniel Keller (EPFL), Katrien Van Look (EPFL)	
31/07/2014	WP6.2	Video conference	Katrien Van Look (EPFL), Felix Schürmann (EPFL), Michael Hines (YALE), Jochen Martin Eppler (JUELICH), Fabien Delalondre (EPFL), Marc de Kamps (ULEEDS)	
01/08/2014	T6.4.1-6.4.3	Skype	Jeanette Hellgren Kotaleski (KTH), Leandro Almeida (ENS), Michele Migliore (CNR), Marja-Leena Linne (TUT)	

Date	Description	Location	Participants	Comments
04/08/2014	SP6	Video conference	Pietro Vidossich (GRS), Stefano Masoli (UNIPV), Daniel Keller (EPFL), Jochen Martin Eppler (JUELICH), Antoine Triller (ENS), Eilif Muller (EPFL), Neil Bruce (HITS), Michael Hines (YALE), Jeffrey Muller (EPFL), Julian Shillcock (EPFL), Katrien Van Look (EPFL)	
22/08/2014	T6.4.1-6.4.3	Skype	Jeanette Hellgren Kotaleski (KTH), Leandro Almeida (ENS), Michele Migliore (CNR), Marja-Leena Linne (TUT), Omar Gutierrez Arenas (KTH)	
04/09/2014 ; 05/09/2014	SP6	EPFL, Switzerland	Alex Ovcharenko (EPFL), Alexander Kozlov (KI), Armando Romani (EPFL), Athanassia Chalimourda (EPFL), Christian Rossert (EPFL), Daniel Keller (EPFL), Daniel Peppicelli (EPFL), Egidio D'Angelo (UNIPV), Eilif Muller (EPFL), Felix Schürmann (EPFL), Heikki Lehvaslaiho (KAUST), Henry Markram (EPFL), Idan Segev (HUJI), Jeanette Hellgren Kotaleski (KTH), Jeffrey Muller (EPFL), Julian Shillcock (EPFL), Katrien Van Look (EPFL), Leandro Almeida (ENS), Marc-Oliver Gewaltig (EPFL), Markus Diesmann (JUELICH), Martin Telefont (EPFL), Martina Schmalholz (UHEI), Michael Hines (YALE), Neil Bruce (HITS), Omar Gutierrez Arenas (KTH), Pablo Campomanes (GRS), Pierre Magistretti (EPFL), Pramod Kumbhar (EPFL), Robert Lindroos (KTH), Sam Yates (EPFL), Sean Hill (EPFL), Srikanth Ramaswamy (EPFL), Stefan Eilemann (EPFL), Werner Van Geit (EPFL)	The first day focused on epic planning and preparation for the HBP Summit and was for all Partners. The second day was for postdocs, PhD students and research assistants. This day was a series of short talks and demos, on Tools and Technologies and Modelling at Multiple Scales.
19/09/2014	T6.4.1-6.4.3	Skype		Attendees unrecorded
29/09/2014	SP6	Heidelberg, Germany	Meeting at the 2nd HBP Summit	Attendees unrecorded
29/09/2014	WP6.3 & WP6.4	Heidelberg, Germany	Neil Bruce (HITS), Rebecca Wade (HITS), Jeanette Hellgren Kotaleski (KTH), Paolo Carloni (GRS), Pietro Vidossich (GRS), Juliette Martin (CNRS), Elisa Frezza (CNRS)	

9.2 Scientific Coordination: HBP Meetings

Date	Description	Location	Participants	Comments
16/06/2014	SP6 & SP5	JUELICH, Germany and video conference	Andrew Davison (CNRS), Jeffrey Muller (EPFL), Sonja Grün (JUELICH), Michael Denker (JUELICH), Alper Yegenoglu (JUELICH)	
16/06/2014	SP6 & SP9	Video conference	Andrew Davison (CNRS), Jeffrey Muller (EPFL)	
24/06/2014	T6.3.3 & T7.2.5	HITS, Germany	Neil Bruce (HITS), Jan Hamaekers (FG), Rebecca Wade (HITS)	
25/06/2014	SP6 & SP8	EPFL, Switzerland	Ferath Kherif (CHUV), Jeffrey Muller (EPFL)	Lausanne, EPFL
26/06/2014	SP6 & SP5	Video conference	Jeffrey Muller (EPFL), José M. Peña (UPM)	
17/07/2014	SP6, SP1, SP2, SP3, SP4, SP5, SP7, SP8, SP9, SP10, SP11	Video conference		Attendees unrecorded
17/07/2014	SP6 & SP9	Video conference	Andrew Davison (CNRS), Jeffrey Muller (EPFL)	
20/08/2014	SP6, SP2 & SP4	VU, The Netherlands	Huibert Mansvelder (VU), Idan Segev (HUJI)	
10/09/2014	SP6 & SP9	Video conference	Andrew Davison (CNRS), Jeffrey Muller (EPFL), Eric Müller (UHEI), Joel Chavas (CNRS), Sebastian Schmitt (UHEI)	
18/09/2014	SP6 & SP8	EPFL, Switzerland	Ferath Kherif (CHUV), Mihaela Damian (CHUV), Jeffrey Muller (EPFL), Cesar Matos (EPFL), Xuesong Lu (EPFL), Thomas Heinis (EPFL), Anastasia Ailamaki (EPFL), Darius Sidlauskas (EPFL), Manos Karpathiotakis (EPFL)	

9.3 Scientific Coordination: External Meetings

This table lists meetings between this SP and Partners outside the HBP.

Date	Description	Location	Participants
07/05/2014	Bank for International Settlements	Basel, Switzerland	Felix Schürmann (EPFL)
19/09/2014	Biopharmaceutical company UCB	EPFL, Switzerland	Felix Schürmann (EPFL)
24/09/2014	Oracle	EPFL, Switzerland	Julian Shillcock (EPFL), Sean Hill (EPFL), Catherine Zwahlen (EPFL), Martin Telefont (EPFL), Kathleen Elsig (EPFL)

9.4 Scientific Coordination: Monitoring & Quality Control

On the coordination side, SP6 established a regular collaboration environment with monthly videoconferences (three in-person meetings) for the entire Subproject and integrated with the HBP collaboration portal. For purposes of quality control, all meetings and preparation of Milestones/Deliverables involve the STO office.

The BSP Specification Deliverable (D6.7.1) introduced a comprehensive phase planning approach for Platform development and modelling tasks, which has been embraced and adopted. The phase planning feeds the measurement of KPIs.

9.5 Scientific Coordination: Additional Comments

Talks given by the Partners at conferences and workshops are listed in EMDESK.

9.6 Scientific Coordination: The Next 6 Months

We will continue with our regular meetings; these are listed (along with the agenda and minutes) on the Collaboration Portal and EMDESK, so that all the HBP Partners can join if they wish. The STO (Martina Schmalholz) is invited to every meeting and receives every email sent to the SP.

Annex A: Milestones

No.	Milestone Name	WP	Month Due	Month Achieved	See Page
MS111	Software application to fit ion channel densities to reproduce any target electrophysiology, v1.	6.1	6	6	10
MS123	Brain Simulation Platform fully specified.	6.5	6	6	10
MS126	Requirements for user documentation and support for Neuromorphic Platform; guidelines for establishing alliances.	6.6	6	6	10
MS112	Software to synthesise cellular morphologies, including projecting axons, v. 1.	6.1	12	Forecast 18	12
MS113	Multi-scale cellular simulator (with a range of neuron models from point neurons to detailed neurons) v1.	6.2	12	12	10
MS119	First draft model of somatosensory cortex.	6.4	12	12	10
MS127	Identification of potential alliances on brain simulation.	6.6	12	Forecast 20	13

Functions: Unified Portal (HBP-UP)

No.	Function Name	Start (plan)	Start (actual)	Complete (plan)	Complete (actual)	Comments
6.5.1.1	Low Volume Scientific Data Sharing, single UP Project with upload	Oct 2013	Oct 2013	May 2014	July 2014	
6.5.1.2	Low Volume Scientific Data Sharing, multi UP Project	Oct 2013	Oct 2013	May 2014	July 2014	
6.5.1.3	Viewing of Data in HBP-UP – Basic Integrated Viewers	Oct 2013	Oct 2013	July 2014	July 2014	A movie are still missing but this will be corrected as priorities dictate
6.5.1.4	Viewing of Data in HBP-UP – Basic Search Integration	Oct 2013	Oct 2013	Sept 2014	Delayed until Jan 2015	Integration of this function with Neuroinformatics Search is Planned
6.5.1.5	Data hiding	Oct 2013	Oct 2013	July 2014	Delayed until Jan 2015	
6.5.1.6	Data Release	Oct 2013	Oct 2013	July 2014	Delayed until Jan 2015	
6.5.1.7	Collaborative Scientific Analysis	Oct 2013	Oct 2013	July 2014	July 2014	
6.5.1.8	Portal Developer services and component reuse	Oct 2013	Oct 2013	*Nov 2014	Not due	Original plan stated Nov 2015, but this was a mistake
6.5.1.9	Portal Developer services and component reuse	On demand	On demand	On demand	Not due	
6.5.1.10	Scientific Developer iterative workflow development	Oct 2013	Oct 2013	July 2014	July 2014	
6.5.1.11	Visualisation Developer component reuse	Oct 2013	Oct 2013	Uncertain	Uncertain	
6.2.1.1	Interactive Atlas Exploration	Dec 2013	Dec 2013	Jan 2015	Not due	
6.2.1.2	The BAEM as a User interface component for cell subset selection	Oct 2013	Oct 2013	Nov 2014	Not due	
6.2.1.3	Interactive Exploration of the Circuit Model	Oct 2013	Oct 2013	Nov 2014	July 2014	
6.2.1.4	Finding data through direct search	Oct 2013	Oct 2013	Nov 2014	Not due	
6.2.1.5	Finding data during Job configuration	Oct 2013	Oct 2013	Jan 2015	Not due	

Functions: Brain Simulation Platform (BSP)

No.	Function Name	Start (plan)	Start (actual)	Complete (plan)	Complete (actual)	Comments
6.1.1.1	Brain Builder	July 2014	July 2014	Nov 2015		
6.1.1.2	Validations	March 2014	March 2014	July 2014	Sept 2014	First Validations Delivered
6.1.1.3	Compound Model and Model Component Analysis	March 2014	March 2014	July 2014	July 2014	
6.1.5.1	Simulation Configure and Launch	March 2014	March 2014	Nov 2014	Not due	
6.1.1.4	Simulation Analysis Tools	March 2014	March 2014	July 2014	July 2014	
6.1.1.5	Collaborative Review Process	March 2014	March 2014	July 2014	July 2014	

Functions: Brain Builder (BB)

No.	Function Name	Start (plan)	Start (actual)	Complete (plan)	Complete (actual)	Comments
6.1.1.6	Repair and diversification of reconstructed morphologies	March 2014	March 2014	August 2014	Delayed until Apr 2015	
6.1.1.7	Synthesise full cell morphologies	March 2014	March 2014	November 2014	Not due	
6.1.3.1	Create a complete Cell model using automated fitting of conductance densities	March 2014	March 2014	November 2014	Not due	
6.1.1.8	Distribute cells and use this to create a point neuron model of a brain region	March 2014	July 2014	January 2015	Not due	
6.1.1.9	Distribute cells and use this to create a point neuron model of a whole mouse brain	March 2014	July 2014	Feb 2015	Not due	
6.1.1.10	Distribute cells and use this to create a detailed neuron model of a mouse neuronal microcircuit	March 2014	March 2014	October 2014	Not due	
6.1.5.13	Simplify the Cellular level model to a Network level model	March 2014	March 2014	October 2014	Not due	
6.1.5.14	Export a volume region of the Cellular level model and add molecular level detail to produce a Molecular level model	March 2014	March 2014	October 2014	Not due	

Functions: Molecular Simulator (MolSim)

No.	Function Name	Start (plan)	Start (actual)	Complete (plan)	Complete (actual)	See Page
6.2.1.1	Geometrically accurate synapse model with molecular reactions and diffusion	Mar 2014	Oct 2014	Apr 2015	Not due	20
6.2.1.2	Molecular Neuron simulation using MolSim	Mar 2014	Oct 2014	Apr 2015	Not due	20
6.2.1.3	MS115 – Parallel Molecular Simulator	Mar 2014	Oct 2014	Apr 2016	Not due	20

Functions: Cellular Simulator (CellSim)

No.	Function Name	Start (plan)	Start (actual)	Complete (plan)	Complete (actual)	See Page
6.2.2.1	Simulation of a microcircuit with biophysically realistic neurons	Mar 2014	Mar 2014	Oct 2014	Sep 2014	22
6.2.2.2	Multi-parameter exploration of medium sized networks with biophysically detailed neurons	Mar 2014	Mar 2014	Oct 2014	Sep 2014	22
6.2.2.3	Full-scale simulation of an entire brain region with biophysically realistic neurons	Mar 2014	Mar 2014	Oct 2014	Dec 2014 (planned)	22

Function Requirements Completion Status: Network Simulator (NetSim)

As noted in D6.7.1, the tracking methodology for NetSim does not track functions in the same way as the other Platform components, but provides a similar level of detail.

No.	Function Name	Month Due	Month Achieved	See Page
M NS1	NetSim: Parallelisation (NFR5)	12	12	24
M NS2	NetSim: Recording device for correlations (SPBSP-FR-020)	12	12	24
M NS3	NetSim: Interfaces (NFR3)	12	12	24
M NS4	NetSim: Efficiency (NFR4)	12	12	24
M NS5	NetSim: Network connection routines (SPBSP-FR-023)	12	Delayed	
M NS6	NetSim: Network connection routines for structural connectivity (SPBSP-FR-024)	15	Not due	
M NS7	NetSim: Current-based neuron models (SPBSP-FR-017)	18	Not due	
M NS8	NetSim: Conductance-based neuron models (SPBSP-FR-018)	18	Not due	
M NS9	NetSim: Synapse and plasticity models (SPBSP-FR-022)	18	Not due	
M NSA	NetSim: Recording devices (SPBSP-FR-019)	18	Not due	
M NSB	NetSim: Stimulation devices (SPBSP-FR-021)	18	Not due	
M NSC	NetSim: Integration of neuron models (NFR1)	21	Not due	
M NSD	NetSim: Spike interaction in continuous time (NFR2)	21	Not due	
M NSE	NetSim: Extensibility (NFR6)	21	Not due	

Annex C: Scientific Key Performance Indicators (SKPIs)

Current KPI information for SP6 is available for review at:

https://flagship.kip.uni-heidelberg.de/jss/CollectKPI?uI=268&s=UJuR3AgTezrb&um=sPO&oSP=6

In its Platform Specification document, SP6 stated its intention to use the Scrum Agile methodology for software development management and KPI monitoring (see D6.7.1, pp 125-133). The process for this was discussed in the SP and put into place at an in-person meeting of the SP in September 2014. Each task in the SP has completed epic (phase) and story planning spreadsheets. Examples of these will be shown at the HBP Period 1 Review in January 2015. For the epic planning, high-level tasks to achieve the milestones are noted and then grouped into phases (taking the milestone due dates into account). The phases correspond to the quarters of the year for the project. For the upcoming quarter, the epics are then broken into smaller stories/tasks, which are sized with points (story planning). Point equivalences are defined in the specification D6.7.1, Section 9.4. The story planning happens at the beginning of ever quarter, taking into account the progress in the previous quarter.

Annex D: Brain Simulation Platform and Unified Portal: Burndown and Stories

BSP and UP Burndown Table (M1 – M12)

Sprint	Start Date	End Date	SPs Planned	SPs Completed	SPs Not Completed	Completion Rate	Total SPs Completed	Total SPs Remaining
0								349
1	18 Nov 13	03 Dec 13	11	7	4	63.6 %	7	342
2	4 Dec 13	19 Dec 13	24	23	1	95.8 %	30	319
3	08 Jan 14	21 Jan 14	28	27	1	96.4 %	57	292
4	22 Jan 14	04 Feb 14	34	14	20	41.2 %	71	278
5	05 Feb 14	19 Feb 14	29	19	10	65.5 %	90	259
6	20 Feb 14	05 Mar 14	21	13	8	61.9 %	103	246
7	06 Mar 14	20 Mar 14	28	15	13	53.6 %	118	231
8	20 Mar 14	03 Apr 14	27	16	11	59.3 %	134	215
9	03 Apr 14	17 Apr 14	33	26	7	78.8 %	160	189
10	17 Apr 14	01 May 14	29	21	8	72.4 %	181	168
11	01 May 14	13 May 14	31	25	6	80.6 %	206	143
12	14 May 14	27 May 14	33	16	17	48.5 %	222	127
13	28 May 14	11 Jun 14	43	27	16	62.8 %	249	100
14	11 Jun 14	24 Jun 14	16	6	10	37.5 %	255	94
15	25 Jun 14	09 Jul 14	28	11	17	39.3 %	266	83
16	09 Jul 14	23 Jul 14	32	28	4	87.5 %	294	55
17	23 Jul 14	05 Aug 14	28	13	15	46.4 %	307	42
18	06 Aug 14	19 Aug 14	26	11	15	42.3 %	318	31
19	20 Aug 14	03 Sep 14	27	13	14	48.1 %	331	18
20	03 Sep 14	16 Sep 14	27	8	19	29.6 %	339	10
21	17 Sep 14	26 Sep 14	12	10	2	83.3	349	0

Note: SP = Story Point. This is a unit employed in the SCRUM agile software development management methodology. The more story points in a story, the more complex it is and the greater the development effort involved.

BSP and UP Burndown Chart (M1 – M12)
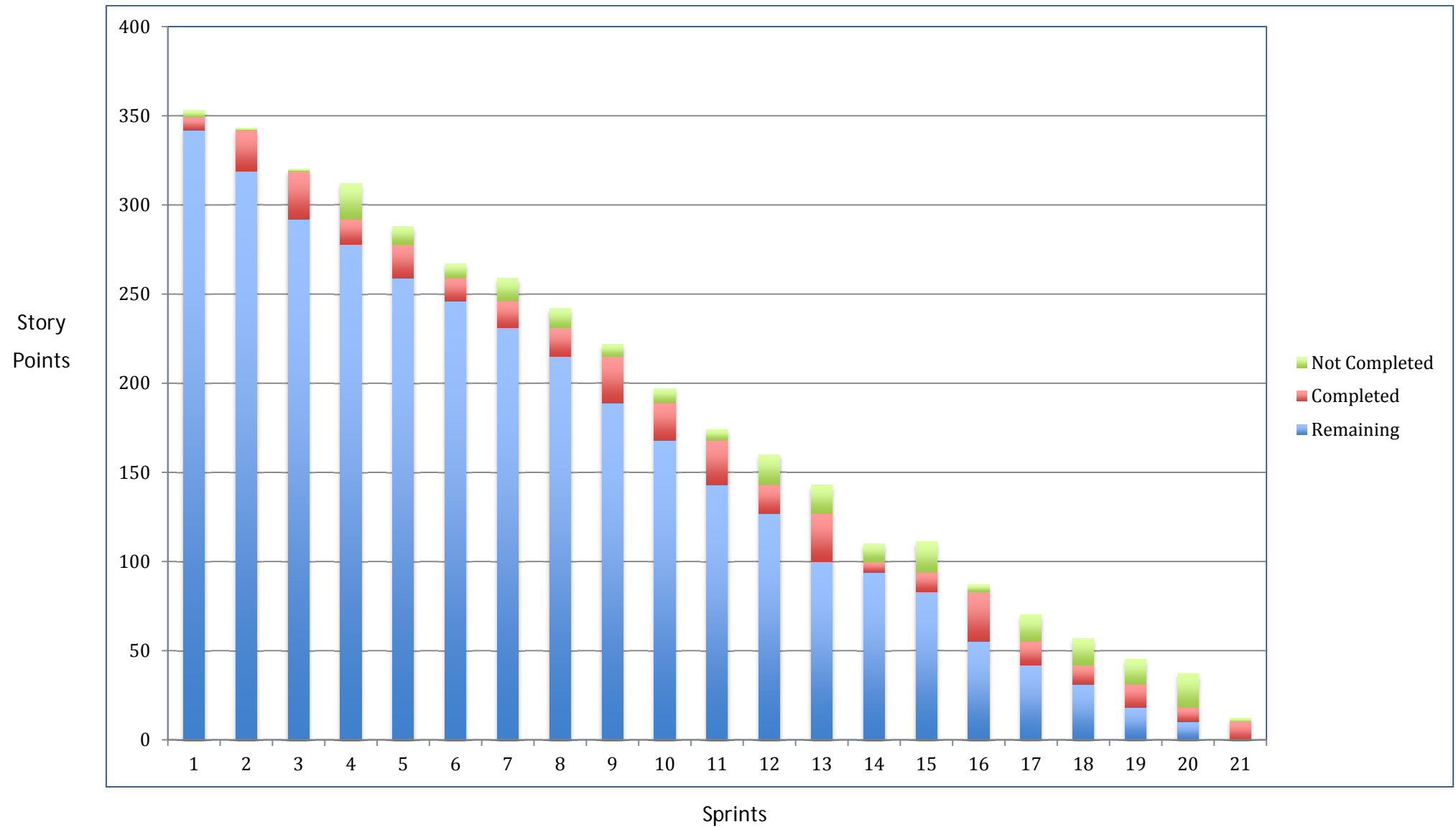
BSP and UP Sprints and Stories Table (M1 – M12)

Sprint No.	Story	Summary	Story Points
1	LBK-478	An SD/DEV user wants to download files from the Document Service API	2
1	LBK-450	As a SciDev I need to be able to update tasks using a Python Service Client API	2.5
1	LBK-422	as a developer, I want to write provenance data in a PROV-DM compatible database through REST call	
1	LBK-420	as a developer, I want to write provenance data in prov-json format through a REST call in the legacy database	
1	LBK-418	As a SU or DEV, I want to be able to develop, run and test a Task locally so that I can deploy them remotely.	2.5
1	LBK-412	As a SciDev I want to list existing Tasks in the Task repository using a Python Service Client API	2.5
1	LBK-411	As a DEV I want to submit tasks for inclusion in the Task repository using a Python Service Client API	20
2	LBK-663	Further Continued - As a SD/DEV I want to be able to launch a trivial Task as a Job on the Slurm queue with inputs that I specify	1
2	LBK-617	Continued - As a SD/DEV I want to be able to launch a trivial Task as a Job on the Slurm queue with inputs that I specify	5
2	LBK-583	As a DEV I want to have a standard approach for NGINX OpenID-Connect Authorization which is blessed by INFRA	1
2	LBK-570	As a DEV I want to have a Ceph Radosgw S3 API which is puppetized	5
2	LBK-569	As a Dev I want Synapse to use the Ceph S3 API and CMB API and store files with handles pointing to iRODS	3
2	LBK-481	As a INFRA I want to use puppet to create a VM with the CMB service	1
2	LBK-479	As INFRA I want to be able to deploy the Task Repository Service with a puppet recipe	1
2	LBK-471	As an SD/DEV I want to be able to retrieve task parameter list and their respective types from the Task repository	3
2	LBK-465	An SD/DEV users wants to upload files with a Python API	1
2	LBK-421	as a developer, I want to navigate through provenance data as PROV-JSON through REST call	3
2	LBK-413	As a SD/DEV I want to be able to launch a trivial Task as a Job on the Slurm queue with inputs that I specify	5
3	LBK-636	As a DEV I want to be able to use NGINX w/ LUA OIDC authentication	3
3	LBK-634	As a DEV I want to be able to query CADO and CWFI relationships from the REST service	3
3	LBK-612	As a DEV I want an mock REST implementation for the Document API	5
3	LBK-611	As a DEV, I want to have an API proposal to serve as an evaluation criteria for implementation strategies.	3
3	LBK-603	Continued - as a developer, I want to navigate through provenance data as PROV-JSON through REST call	1
3	LBK-593	Continued - As INFRA I want to be able to deploy the Task Repository Service with a puppet recipe	3
3	LBK-564	As a SCIDEV I want the Validation API to allow easy comparison of distributions stored in numpy arrays, according to acceptable validation practices.	5
4	LBK-720	As a SCIDEV I want a non-trivial example of a validation using the Validation toolkit	3
4	LBK-676	As a DEV I want testing of the common Makefile.	3
4	LBK-675	As a DEV I want be able to have clear documentation about Platform Python Development Standards and Workflow	3
4	LBK-400	As a Scientific User I want to be able to manage projects	5
4, 5	LBK-677	As a DEV I want an Proof-of-concept for a simple way to tag and release my code	3
4, 5, 6	LBK-662	As a DEV I want a standard approach for handling dependencies in both Jenkins plans and virtualenvs	1
4, 5, 6, 7	LBK-682	As INFRA I want to have a staging deployment mechansim for NGINX and OIDC	1
4, 6	LBK-657	As a DEV I want the core functionality of the Document Service API to be implemented	1
4, 6, 7	LBK-656	As a DEV I want instances of iRODS to work with for development purposes	1
4, 8	LBK-595	Continued - An SD/DEV users wants to upload files with a Python API to the Document Service	1

Sprint No.	Story	Summary	Story Points
5	LBK-742	As a DEV, I want the user profile services API to be implemented	3
5	LBK-681	As a DEV I need a production OIDC service	1
5	LBK-680	As a DEV I need an allocation of VMs for the OIDC service	1
5	LBK-610	As an SU, I want to be able to launch a jobs using scipy with the python Task Framework client API	3
5	LBK-401	As a Scientific User I want to be able to modify existing project content.	5
5	LBK-399	As a Scientific User I want to be able to view the content of a project.	3
5, 6, 7, 17	LBK-743	As an SU, I want to be able to launch validation jobs using the python Task Framework client API with Bluepy dependencies	1
6	LBK-785	As a User I want a clear process to create Platform feature requests	1
6	LBK-782	As DEV, I want a procedure for deploying modules on the target platforms	4
6	LBK-781	As DEV, I want a procedure for defining and creating modules on the target platforms	5
6	LBK-776	As a DEV I want to know how to balance customer request with task in the scrum	1
7	LBK-856	As a SD/DEV I want a bluepy package which is pip installable	1
7	LBK-854	As a DEV I want Platform Standard environment modules for BBPSDK	5
7	LBK-818	As a SU/DEV I want to access the Document Service through a Swagger generated Python Client.	3
7	LBK-737	as a SD/DEV, I want a working non-trivial example on how to be able to register a simple command line task.	3
7	LBK-679	As a Dev I need to have an allocation of a dev and staging VM for Document service	1
7, 8	LBK-855	As a DEV I want to have a separate bluepy's viz dependencies into a separate package while maintaining API compatability	1
7, 8	LBK-768	As a Scientific User I want to be able to see Document Service entity metadata attributes through the Web UI	1
7, 8	LBK-758	As a DEV, I want the user group services API to be implemented	3
7, 8	LBK-674	As a Scientific User I want to be able to edit Document Service file metadata attributes through the Web UI	1
7, 8, 9	LBK-659	As a DEV I want to be able to use the non-standard attribute Metadata functionality of the Document Service REST API spec	1
8	LBK-933	As a Dev I want to have a standard tool page in confluence with can be generated from the common make system.	3
8	LBK-893	As a User, I want to be able to authenticate against the SSO in the WebUI	3
8	LBK-885	Finish Remaining Education Portal Tasks	3
8, 9	LBK-895	As a User, I want the Document Service permissions/business rules to be implemented so that I can trust that my data is safe	1
8, 9	LBK-894	As a DEV I want the Document Service to maintain the ACL database	1
8, 9	LBK-891	As a DEV I want a specified datatype standard	1
8, 9	LBK-881	As an Ethics Team member I want a private site to collaborate with other members of the Ethics Team	1
8, 9	LBK-403	As a Scientific User I want to use the Web UI to add and remove users who can view, edit and administer a project	3
9	LBK-1004	As a DEV I want a pip-installable pybinreports package	3
9	LBK-1002	As a USER I want to be able to select a task from an entity based on the MIME type	2
9	LBK-955	As a User, I want a expiring, signed URL that I can download a file from securely.	3
9	LBK-741	As a Developer I want an equivalent solution to ProxyPyPi for javascript	3
9	LBK-473	As a SU/DEV I want an implementation of the datatype specification use cases	3
9	LBK-414	As a SD/DEV I want to be able to request a List of *my* Jobs from the Broker	3
9, 10	LBK-1003	As a USER I want to be able to run some previous analysis tasks using the task manager.	1
9, 10	LBK-956	Dev wants to use OIDC group service which is deployed in production	1

Sprint No.	Story	Summary	Story Points
9, 10	LBK-952	As a dev I want to use Swagger API for the Task Service in Python	1
9, 10	LBK-445	As a UI-DEV I need to create a generic configuration web UI using the input parameters of a task	2
9, 10, 11	LBK-417	As an SD/DEV I want to retrieve result graph from *my* previous Jobs runs	1
10	LBK-1079	As a PLATDEV I want a service to return a Blueconfig as json	3
10	LBK-1061	As a User I want a URL from a view of the browser that restores the browser view for me.	3
10	LBK-1058	As a User I want to be able to query the list of Users/Groups	1
10	LBK-1057	As a DEV/INFRA I want users with membership in a particular group to be able to modify hbp-* group memberships	1
10	LBK-1038	As a User I want the SSO site to provide me with confidence that it is an official HBP service	1
10	LBK-1019	As a SD I want my editor to simply show pep8 and pylint errors	1
10	LBK-555	As a SciDev I want the Container manager to stage input files from document service via download mapping	2
10	LBK-553	As a SciDev I want the Job Broker to automatically upload Job configuration to document service on Job start so I can retrieve them later in Web UI or Python Client	3
10, 11	LBK-1078	As a User, I want to be able to view the Blueconfig in the detail viewer using a specialized viewer	3
10, 11	LBK-1077	As a user I want to see the rich detail view, launchable from the list view	3
10, 11	LBK-556	As a SciDev I want to upload job output files to the document service from the Container Manager	1
11	LBK-1176	As a SD/DEV I want the document service to support groups in ACLs	1
11	LBK-1175	as a dev I want a way to push a artifact for a complete application	1
11	LBK-1174	as a dev I want a spec for how to deal w/ service interdependency configuration	2
11	LBK-1121	As a SU I want to use the WebUI in the dev environment	3
11	LBK-1110	An SD/DEV users wants to register /gpfs/bbp.epfl.ch or /gpfs/bbp.cscs.ch files as external links with a Python API	2
11	LBK-469	As a SD/DEV, I want the Job inputs and outputs to be tracked in the Provenance Service	2
11	LBK-424	As a Dev, I want to query the REST provenance API through a convenient python client.	1
11, 12, 13	LBK-609	As a DEV I want to be be able to use the same Parameter Types in Provenance that we use in Task inputs.	3
11, 12, 13, 14	LBK-808	As a DEV I want instances of document service (including iRODS) to work with for deployment purposes	3
12	LBK-1199	As a SU I want to specify the output project for my Task execution	2
12	LBK-1129	As a SU, I want to be able to run a Task as a Job with an extern link file as input.	1
12	LBK-1118	As an SU or SD I want a command line tool to register a single existing Simulation on /gpfs/bbp.cscs.ch/ in the portal	2
12	LBK-1117	As an SU or SD I want a command line tool to register a single existing Circuit on /gpfs/bbp.cscs.ch/ in the portal	2
12	LBK-1109	As a User, I want to restore a view that points to a folder that is deeply nested in a parent containing tons of other items	3
12	LBK-554	As a SD/SU I want to run a Spike Raster or PSTH Plot analysis on an extern link Simulation	1
12	LBK-470	As an SD/DEV I want to be able to find and read documentation on the Task SDK and local testing environment	1
12	LBK-243	As a SU I need to know how to install the programmatic service clients on my local machine.	1
12, 13	LBK-1122	As a SU/SD I want to see a circuit in its 3d location in a 3d view of a rat brain	5
12, 13	LBK-1120	As an SU/SD I want to get a local path to the file contents of externlinks from the Document service	1
12, 13	LBK-1062	As a user I want to see the artifact provenance in the project browser	3
13	LBK-1343	As a Scientist, I want my task to output to a specific folder	3
13	LBK-1342	As a DEV, I want to be able to sort the viewers in the Document Browser	2
13	LBK-1333	As a user I want my task outputs to be organized by category	

Sprint No.	Story	Summary	Story Points
13	LBK-1303	As a Product Owner I want the UI to look as good as possible for the MVP demo	3
13	LBK-1300	As a User, I want the file in browser detailed view to be ordered by selection of the sorting icon	2
13	LBK-1289	As a User, I want the project and folder ordered by name in the browser	1
13, 14	LBK-1302	As a user I want to access the Unified Portal interface at an easy to remember URL	1
13, 14	LBK-1210	as a DEV, I want to use a consistent set of REST APIs.	2
13, 14, 15, 16	LBK-1198	As a DEV I want to be able to use the equivalent bluepy module on CSCS viz that I use on EPFL viz	2
13, 14, 15, 16	LBK-608	As a DEV I want to be able to launch Task as jobs on the CSCS viz cluster	3
14	LBK-1370	As a User, I want to list all the downstream jobs that has been ran for the current entity	
14	LBK-1361	As a User, I want the job to list current and past job	
14	LBK-1360	As a User, I want a job manager to open when I click the Jobs tab	
14	LBK-1358	As a User, I want to log out from the web UI	
14	LBK-1357	As a User, I want to see my name in the top bar	
14, 15	LBK-1362	As a User, I want to view the task definition from a job execution	2
15	LBK-1397	As a user I want to be able to upload a file or set of files into a Document Service Project from the WebUI	3
15	LBK-1364	As a User, I want to see a bunch useful quick links on the homepage	
15	LBK-1355	As a DEV I want a strategy to have Jobs output data to GPFS	
15, 16	LBK-1412	SPIKE - Evaluate a solution and prepare a proposal to INFRA for the puppet repo mgt.	
15, 16	LBK-1285	As a DEV, I want to be able to generate a new token to interact w/ backend services	3
15, 16	LBK-1216	As a User I want to have a more intuitive menu for selecting between the various collaboration sites	2
16	LBK-1435	As a User I want the circuit viewer to show a default target.	1
16	LBK-1430	As a user I would like to see the content type in the right-hand list view	1
16	LBK-1393	As an SU I want the post-simulation workflow to run the spike_raster plot	2
16	LBK-1375	As a User, I want a way to get back to the entity detailed view from a downstream job entity detailed view	1
16	LBK-1374	As a User, I want a list of summaries for all the downstream analyses	1
16	LBK-1371	As a User, I want to display only validations and analyses, grouped by types	2
16	LBK-1369	As a User, I want a project selection splash screen	1
16	LBK-1214	As a Communications Manager I want to have a form for entering a media request	2
16, 17, 18, 19, 20	LBK-1353	As an SD I want to be able to write and run tasks which output primary data to GPFS	2
17	LBK-1516	As a Developer I want a documentation package which explains to me how to use the OIDC service	1
17	LBK-1514	As a User I want to the Button style in the Circuit viewer to follow the same style as the rest of the Project Browser	1
17	LBK-1494	As a User I want to be able to quickly "Show all" visible entities in the circuit Viewer	1
17	LBK-1476	As a User I want the tasks to be grouped by category/name/version in the Action menu and detail view sidebar	2
17	LBK-1456	As a user I want a link to the task browsable code (gitolite for instnance) when displaying the link to code in the Job detail view	1
17	LBK-1396	As an SU I want the post-simulation workflow to run voltage_collage analysis	1
17	LBK-1373	As a User, I want a list of summaries for all the downstream validations	2
17	LBK-1128	As an SU, I would like to convert soma binary reports to h5 format using a SomaBinary2H5 Task	1
17	LBK-1116	As a SU I would like to have a voltage collage plot for a given simulation	1

Sprint No.	Story	Summary	Story Points
17, 18	LBK-1497	SPIKE - Hotfix build proof of concept.	
17, 18	LBK-917	As a DEV, I want a finalized spec for the Validation report object	1
17, 19, 20	LBK-1524	As a NeuroInfomatics User I want a mockup of the new navigation structure using static HTML	2
17, 19, 20	LBK-1486	As a dev, I want provenance to distinguish between file creation and file typed return value.	2
18	LBK-1573	As a Platform Dev, I want to be able to add top-level menu components	3
18	LBK-1559	As a Scientific User I want a Platform standard environment module for mpi4py	2
18	LBK-1556	As a Dev I want to have a service which provides metadata for Content types	1
18	LBK-1124	As an SD I want to view Validation Reports in the detail view.	2
18, 19	LBK-1572	As a Scientific User, I want to run the pathway.h5 generation from the mesobuilder	3
18, 19	LBK-1562	As a User I want the UP to have the icon-less common menu bar	1
18, 19	LBK-1558	As a User I want Read-Only access to all release circuits	1
18, 19	LBK-1551	As a DEV I want a specification for Bundle V1	2
18, 19, 20	LBK-1548	As a Platform Dev I want the accreditation interface in the User Profile control interface to be functional	1
19	LBK-1677	As an App Developer, I want to scaffold a new project structure, as to get started properly with the correct HBP environment setup	
19	LBK-1623	As a SD I want to be able transform a BlueConfig from the /bgscratch standard to the /gpfs/bbp.epfl.ch standard	2
19	LBK-1621	PLACEHOLDER: As a user I want to view arbitrary project resources in the UP (Document Service)	
19	LBK-1620	As a SU/SD/etc I want a jira ticket queue to submit tickets	
19	LBK-1619	As a Scientific User I want to be able to right-click download from the image previewer.	
19	LBK-1617	As a HBP Employee, I want a demo of the HBP Platform	
19	LBK-1549	As a DEV I want to be able to Create a new accredited User using the User Profile Service	3
19	LBK-1425	As a User I want to kill running jobs from the Job Service client API	3
19	LBK-1424	As a User I want to kill running jobs from the Job Manager UI	1
19, 20	LBK-1618	As an admin, I want a utility to assign SP manager to the right groups	1
20	LBK-1040	as a new external User, I want to get my password when my account is created.	
20, 21	LBK-1693	As a User I want to view documentation on a project service.	2
20, 21	LBK-1045	As an EPFL or Non-EPFL user I want to reset my password	1
20, 21	LBK-867	As a dev, I want the provenance database to be upgraded.	2
21	LBK-1814	as INFRA, I want a form in the HBP Collab portal to update user profile with gender, birthdate and SP	2
21	LBK-1771	As a User I want the recent enhancements of the common menu bar	1
21, 22	LBK-1766	As a Scientific Developer I want to be able to submit a task to a Gerrit repository for registration by the Platform team	2

Annex E: Backlog

Backlog: Network Simulator (NetSim)

No.	Internal ticket no.	Description	Milestone	Status
SPBSP-FR-017-01	#230	*Review use of status flags in class Node.* Each Node has a bitset stat_, which encodes the status of the node. The meaning of the individual bits is determined by the enum flag. Most of the flags are, however, not used. This needs to be fixed to reduce code complexity and increase maintainability	M NS7	
SPBSP-FR-017-02	#693	*Some models are inappropriately re-using variable names.* For faster access during parameter setting and retrieval, NEST uses predefined Name objects internally. These are erroneously re-used in some models for different meanings. Such instances need to be fixed to make the user interface more consistent.	M NS7	
SPBSP-FR-018-01	#756	*Write unit test for iaf_cond_alpha_mc.* To ensure correctness, neuron models in NEST are accompanied by a unit test. For the simple three-compartment model iaf_cond_alpha_mc this test has still to be written.	M NS8	
SPBSP-FR-018-02	#837	*Make Create talk about GSL if a model is not found.* One frequent source of error when trying to create model instances is that NEST was compiled without support for the GNU Scientific Library (GSL), which is needed for the conductance based-models. Because of this, Create should hint the user in this direction.	M NS8	
SPBSP-FR-019-01	#465	*Improve Multimeter and UniversalDataLogger.* The multimeter model allows recording analog quantities of the network in NEST. Currently, initialisation of the logger is carried out in the class hosting the logger, breaking the abstraction. This requires refactoring.	M NSA	
SPBSP-FR-019-02	#426	*spike_detector fails assertion in network with connections setting multiplicity to zero.* The multiplicity of a spiking event can be used to bundle events. In some synapse models, this gets set to 0, which breaks NEST. These situations need to be investigated further.	M NSA	
SPBSP-FR-021-01	#427	*Review noise_generator.* The noise_generator currently creates colored noise rather than white noise. The effect of this needs to be documented and other noise processes have to be explored.	M NSB	
SPBSP-FR-021-02	#721	*Review smp_generator and generator naming.* The poisson_generator creates a different Poisson spike train for each stimulated neuron, while the smp_generator supplies all targets with the same train. This behaviour should be reviewed and at least made obvious through a name change.	M NSB	
SPBSP-FR-021-03	#735	*Review naming of parameters for generator models.* Similar to what is described in SPBSP-FR-017-02 above, generators are also re-using names in an inconsistent manner. Consistency needs to be reviewed and improved.	M NSB	
SPBSP-FR-022-01	#730	*Review naming, setting and documentation of synapse parameters.* Many parameters exist in multiple synapse models. However, they are named inconsistently in different synapse models, which makes it hard for the user to infer them without an in-depth consultation of documentation. Consistency needs to be reviewed and improved.	M NS9	
SPBSP-FR-023-01	#701	*Remove Connect functions depending on syn_id.* For evaluating the effect of certain optimisations, some connection functions in NEST were using the internal synapse model ID rather than the symbolic name on the level of the user interface. This is dangerous, as the mapping between names and IDs just reflects the order of initialisation. Furthermore it has turned out that the new functions are not faster than the old ones. These functions have thus to be removed and all scripts using them need to be adapted.	M NS5	Done

No.	Internal ticket no.	Description	Milestone	Status
SPBSP-FR-023-02	#704	*Create tests for new connection routines with ranges.* Many newer connection routines can operate on lists of pre- and post-synaptic neurons and devices rather than just on single nodes. These functions are lacking unit tests to ensure their correctness.	M NS5	
SPBSP-FR-023-03	#643	*Review connection counting mechanism.* To be able to inform the user about the number of existing synapses, they get counted during network setup. The mechanism for this is not thread-safe, which leads to a wrong number in certain situations. The algorithm needs to be reviewed and fixed.	M NS5	
SPBSP-FR-023-04	#553	*RandomPopulationConnectD can only handle source arrays with contiguous GID ranges.* The argument list of some bulk connection routines expects the list of IDs of neurons or devices to be continuous, which is inflexible. All connection routines have to support arbitrary lists of IDs as their input.	M NS5	Done
SPBSP-FR-023-05	#740	*Revise bulk-connection routines to use thread-aware connect functions only.* NEST has a serial and a parallel version of the basic one-to-one connect function internally. Only the parallel version should be used to allow for transparent parallelisation of the code.	M NS5	Done
SPBSP-FR-023-06	#828	*Allow flexible parameterisation of synapse parameters.* To randomise synapse parameters like weight or delay, the user has to draw these numbers manually in Python or NEST and provide them to the NEST simulation kernel. This is inefficient and should be replaced by a mechanism to draw parameters from user-defined distributions.	M NS5	Done
SPBSP-FR-023-07	#679	*Clean up RandomPopulationConnectD.* This bulk connection routine was written as a prototype and needs to be cleaned up to make it production-ready.	M NS5	Done
SPBSP-FR-023-08	#672	*Copy-pasted RandomDivergentConnect description is wrong.* The documentation of this prototypic bulk connection routine was copied from another connection routine and still contains old text. This needs to be updated and corrected.	M NS5	Done
SPBSP-FR-023-09	#831	*Test uniform and lognormal RDVs.* The new random deviate generators for uniform and lognormal distributions need unit tests to ensure that they are working correctly.	M NS5	Done
SPBSP-FR-024-01	#561	*Allow connections from/to selected nodes in topology layer.* Using ConnectLayers, the Topology module creates connections between all neurons in the source/target layers. It would be desirable to only connect a selected subset. This possibility has to be investigated and possibly implemented.	M NS6	
SPBSP-FR-024-02	#738	*Review Topology Online Documentation.* The online documentation of ConnectLayers does not explain all parameters. The missing parameters have to be added and the complete documentation has to be checked for similar errors.	M NS6	
SPBSP-FR-024-03	#800	*Add checks on Parameter parameters in Topology.* The parameters in the Topology module do not check if they are plausible, which can lead to errors such as divisions by zero and similar. Parameter checks for such parameters have to be added.	M NS6	
SPBSP-NS-NFR1-01	#618	*iaf_psc models misbehave if tau_mem == tau_syn.* If the membrane time constant is set to the synaptic time constant, a division by zero is caused in the current-based models. Setting such parameters should not be possible and an error should be thrown instead of accepting the values.	M NSC	
SPBSP-NS-NFR2-01	#722	*Review comments in precise models.* The comments in the canonical versions stem from older versions of the model and were not updated when the code was. The comments need to be changed to be consistent with the current code.	M NSD	

No.	Internal ticket no.	Description	Milestone	Status
SPBSP-NS-NFR2-02	#796	*Create examples for precise timing models.* The precise models in NEST are not easily accessible as there is only one example at the moment. To increase the visibility and make it easier for users to use the precise models, some new examples have to be created to show the usage of precise neuron and device models.	M NSD	
SPBSP-NS-NFR5-01	#600	*Deprecate Pthreads.* The explicit parallelisation based on POSIX Threads has been superseded by more fine-grained parallelism using OpenMP. The old code can thus be removed.	M NS1	Done
SPBSP-NS-NFR5-02	#858	*Use Network::get_thread_id() instead of omp_get_thread_num().* Many locations in NEST query the number of threads using the basic OpenMP function omp_get_thread_num(). This is dangerous if NEST was not built with support for threading and the internal function should be used instead	M NS1	Done
SPBSP-NS-NFR6-01	#617	*Remove module unloading functionality.* Modules allow to extend NEST by adding new neuron, synapse and device models and general functions to NEST's simulation language interpreter SLI. In the beginning it was possible to unload modules, but it turned out that it is almost impossible to make this work reliably because modules can have side-effects that cannot be traced. Thus the functionality for unloading should rather be removed.	M NSE	
SPBSP-NS-NFR6-02	#290	*Functions defined in modules are imported to global namespace.* The functions defined in Modules are put in the global namespace, while their wrapper functions for dispatching the right function based on the argument types are in a special namespace. It has to be decided where both components should be de1ned and the code has to be adapted accordingly.	M NSE	
SPBSP-NS-NFR6-03	#526	*MyModule build system needs a rework.* The build system of the example MyModule has not been adapted in the last few versions of NEST and needs to be adapted to the current versions of tools and conventions.	M NSE	
SPBSP-NS-NFR6-04	#558	*ResetKernel should reset modules.* ResetKernel deletes the network in NEST and resets all dynamic states to their defaults. This should also happen for modules. A corresponding hook needs to be added and used in the dynamic loader.	M NSE	

Annex E: References

1) Kunkel et al. (2014) Kunkel, Susanne and Schmidt, Maximilian and Eppler, Jochen Martin and Plesser, Hans Ekkehard and Masumoto, Gen and Igarashi, Jun and Ishii, Shin and Fukai, Tomoki and Morrison, Abigail and Diesmann, Markus and Helias, Moritz (2014) Spiking network simulation code for petascale computers. *Front. Neuroinform.* **8**:78. doi: 10.3389/fninf.2014.00078