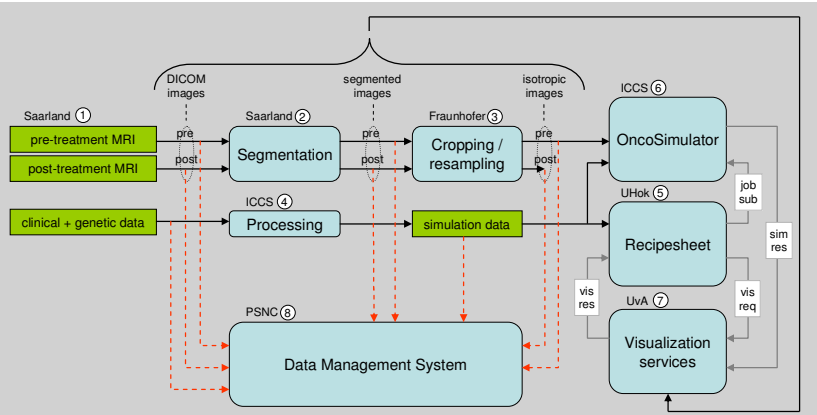
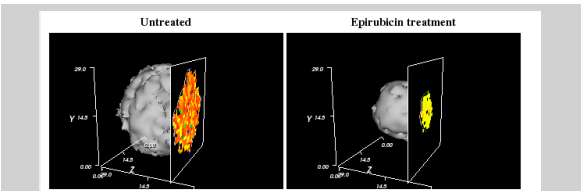




The ACGT Oncosimulator

The ACGT Oncosimulator is an integrated, secure Grid-based system for patient-specific simulation of the response of a tumour and surrounding tissue to various forms of therapy. The validation of the simulation code is an activity requiring extensive human-driven visual investigation of the influence of each of the dozens of parameters to the code, and comparison of the simulation results against the known outcomes of past patients treatments.

The simulator is being used to investigate the growth and treatment of nephroblastoma and breast cancer.



Schematic representation of the integrated Oncosimulator. (1) the simulator is designed to process patient specific data, (2) tumours are manually outlined in medical images, (3) images are cropped and resampled, (4) patient and pharmacodynamic factors are prepared for input by the simulator and Recipesheet, (5) the Recipesheet controls job execution and representation of simulation results, (6) the OncoSimulator executes on the Grid, (7) simulation results are visualized at the request of the Recipesheet, (8) all data is stored in a central Data Management System (DMS).

Objectives

Before the simulator can be adopted as a tool for clinical practice, its developers must confirm that the simulator behaves consistently and predictably as each of its inputs is varied, individually and in concert, over ranges of plausible values. For this 'validation' phase, we implemented a spreadsheet-inspired environment that includes explicit support for users to set up and manipulate multiple alternative application states in parallel: the OncoRecipeSheet.

Deployment

We installed a preliminary version of the OncoRecipeSheet at two sites, including the simulator developers' group, in the summer of 2009. Since then, the users explored over 3,500 simulations for the two cancer types being examined. Although in general the simulator has proven to be robust and predictable across a broad range of parameter settings, the ability to run and to inspect large numbers of simulations has already helped us to uncover some unexpected behaviours. The generation of simulation results over the past year has constituted a useful stress-test of the ACGT Grid infrastructure, bringing to light many issues that we were then able to resolve, thus improving the reliability and performance of the overall system.

Challenges

The implementation of this work adopts the following design challenges:

- **The user is in charge:** the application must support human-guided exploration.
- **A large parameter space:** the application must support exploration of the simulator's ~40 parameters that span a space of at least 10²⁰ possible results.
- **Comparison is key:** validation requires that the user is able to compare results between multiple parameters.
- **Support interactive visualisation:** the results from the Oncosimulator include representations of the tumour shape in three dimensions. To understand the shape of the tumour, the user must be able to interact with the view: change orientation or take slices.

