# Project FlowOpt (Workflow Optimizer)

**Project goal:** The aim of the project is to develop a single-user multi-platform software for editing, visualizing, optimising, and analyzing workflows.

**Detail description:** Workflow is a set temporally and logically connected activities describing some process, for example producing some artefact, organizing an experiment, booking a trip etc. Activities may require resources for execution, for example, machines, workers etc. The proposed software will allow creating a workflow from scratch or importing a workflow in some widely-used workflow modelling language. Workflows can be visualised (described graphically), edited, and saved in selected modelling language. After creating the set of workflows and specifying available resources, the system will generate a schedule optimizing a specified criterion such as makespan or cost. The generated schedule will be displayed as a Gantt chart and it will be possible to modify the schedule by moving activities in time and space. The schedule can be exported to a file and imported from file as well. The system will allow automated repair of possible violation of constraints after manual editing. A set of schedules can be compared; in particular, various parameters of schedules, such as cost, makespan, resource utilisation, overtime etc. can be compared in 2D graphs.

**Functionality of Modules:**

*Workflow Editor:*

- Importing and exporting workflows in existing formats (such BPML/XPDL, YAWL, etc.) including recovery from errors in input data and transformation of supported patterns to internal representation (unsupported patterns are reported to user and ignored); the workflow can also be generated from scratch
- Visualising workflows in the form of a graph with left-to-right and top-down orientation and structural zooming (hiding nests); a hierarchical view (a tree structure) for displaying nested structures; displaying temporal and logical relations between activities and additional attributes such as duration, required resources, cost etc.
- Editing workflows in two modes: constrained mode for editing workflows with fully nested structure (such as Nested TNA) and unconstrained (freelance) mode for general workflows; unconstrained mode will support checking of workflow soundness with reporting errors and suggesting how to repair them (it is possible to detect nested structures)
- Printing workflows to PDF??

*Workflow Optimiser (Scheduling Engine):*

- Allocating activities to available resources and time while optimising selected objective function
- The basic input is supposed to be similar to Resource Constrained Project Scheduling Problem with optional activities connected via logical relations to be allocated to unary and possibly cumulative resources where the objective is a combination of earliness, tardiness, and cost for alternatives; over-subscribed scheduling is supported

- o Each activity has fixed duration, due date, earliness cost, tardiness cost, and execution cost
- o Activity may require several resources
- o Any two activities can be connected via temporal constraints (start-to-start, end-to-start, start-to-end, end-to-end) and logical constraints (exclusion, equivalence, implication, disjunction)
- o Activity can be decomposed into a set of activities; alternative and parallel decompositions are supported; some temporal and logical constraints are implicitly included

- Based on constraint satisfaction technology

*Schedule Visualizer (Interactive Gantt Viewer):*

- Visualizing schedules in the form of Gantt chart; resource and task views supported; time and structural (nested structure) zooming; highlighting violated constraints and highlighting activities belonging to a single workflow
- Interactive changes of the schedule include changing position of activities in time and moving to different resources; adding/removing activities, resources, and temporal constraints; constrained and unconstrained changes supported
- Automated correction of violated constraints (no optimisation)
- Importing and exporting schedules in own format (includes error recovery)
- Printing schedules to PDF??

*Schedule Analyser:*

- Comparing selected attributes of schedules in a graphical form; 2D graphs will display two attributes of each schedule; support for combination of attributes
- Manual selection of a set of schedules in graphs (the selected set is highlighted in all other graphs); selection of schedules based on user specified criteria
- Printing graphs to PDF??

*Project Manager (System Orchestration):*

- Integration of all modules and transferring data between modules, for example, generating data for scheduling
- Managing of projects; project consists of a set of workflows, additional information such as a set of available resources (including calendars of availability), and generated schedules; projects can be saved in a file and loaded from the file

**Architecture:**

Workflow Editor, Scheduling Engine, Gantt Viewer, and Schedule Analyser are independent modules and each module can be encapsulated to form a separate application (with the exception of Scheduling Engine, they all have a graphical user interface). The system will allow simple change of any of these modules for a new version. The modules will communicate via standard interface which

will allow the modules to run on different machines, for example, the scheduling engine runs on a powerful server computer, while the user interfaces run on a local computer.

Project Manager is evoked first as the main module and calls all other modules. When the user adds a new workflow, Workflow Editor is evoked to visualise and edit this workflow. The user can specify available resources in the project editor and when the scheduling is evoked by the user, information about workflows and resources is combined to formulate a scheduling problem. The generated schedule is stored within the project and the Project Manager can call the Gantt Viewer to display the schedule (for example automatically after the schedule is generated). Schedules manually modified in Gantt Viewer are stored within the project too. The set of schedules can be compared using Schedule Analyser. The following figure shows the architecture of the system, data transfer links, and interaction with external environment (user, file system).
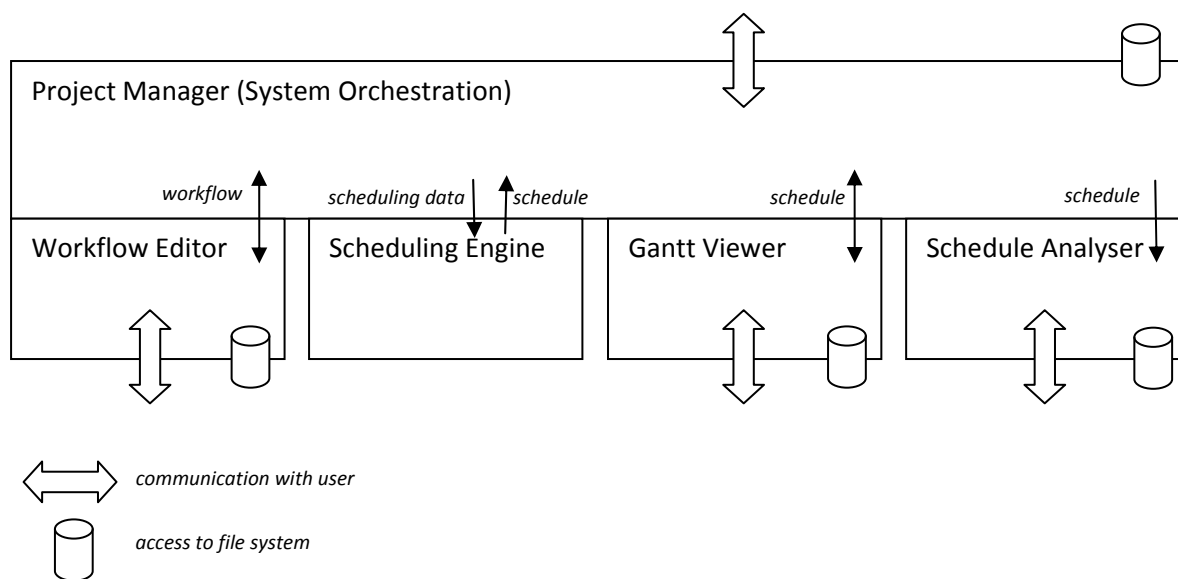


**Proposed team:**

- Vladimír Rovenský (Workflow Editor)
- Milan Jaška (Scheduling Engine, Orchestration)
- Tomáš Skalický (Gantt Viewer)
- Matěj Klonfar (Schedule Analyser, auxiliary tasks)

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