Presentation of PhD Topic

Cloud Computing
for Simulations of Dissemination
Pollutants from Industrial Enterprises

Formal Methods Seminar
Hagenberg, Austria
October 24, 2012

Overview

- Relevance

- The task

- How software works

- Why cloud computing?

- Novelty

- The simulation method

- The research work's plan

- Development tools

Relevance

- A lot of industrial processes involve chemicals dangerous to the environment.

- Nuclear energy is one of the main sources of power.

- Protection of the environment is one of the main goals for humanity.

- The preparedness to the accidents on the industrial enterprises reduces the negative effects of the accidents.

The task: (1/2)

- Development of the software for cloud computing to simulate the movement of pollutants in the atmosphere.

- Development of API interface for this software intended to add the introduction of mathematical models for the user's modeling tasks.

- Simulation of different weather conditions and simulation of the pollutants spreading in these weather conditions.

- Providing of the ability to download tasks for modeling as a single file or with the help of the task constructor.
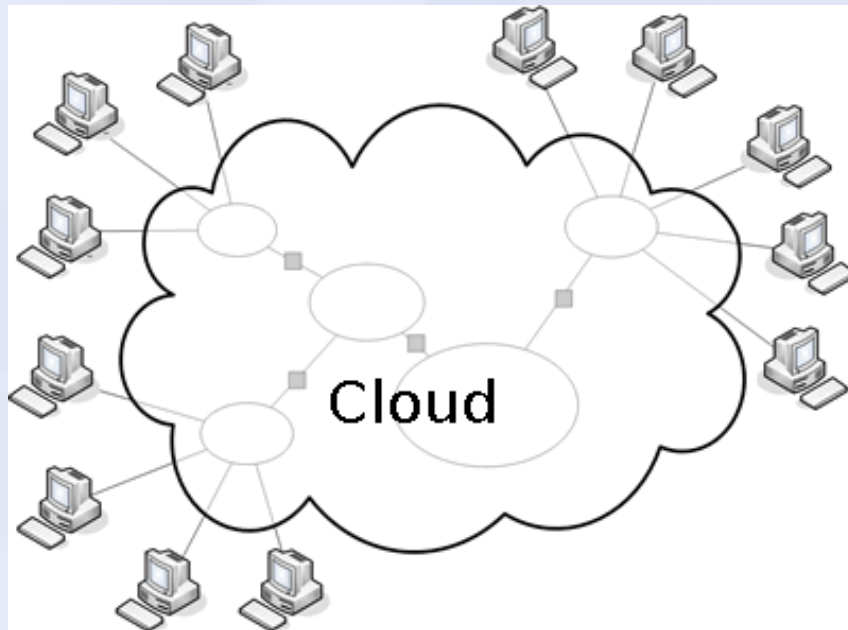
The task: (2/2)

- Visualization of the results with the help of 3D graphics.

- Saving of the results and creation of the tasks library.

- Providing of the secure access to the software.

Example of task:
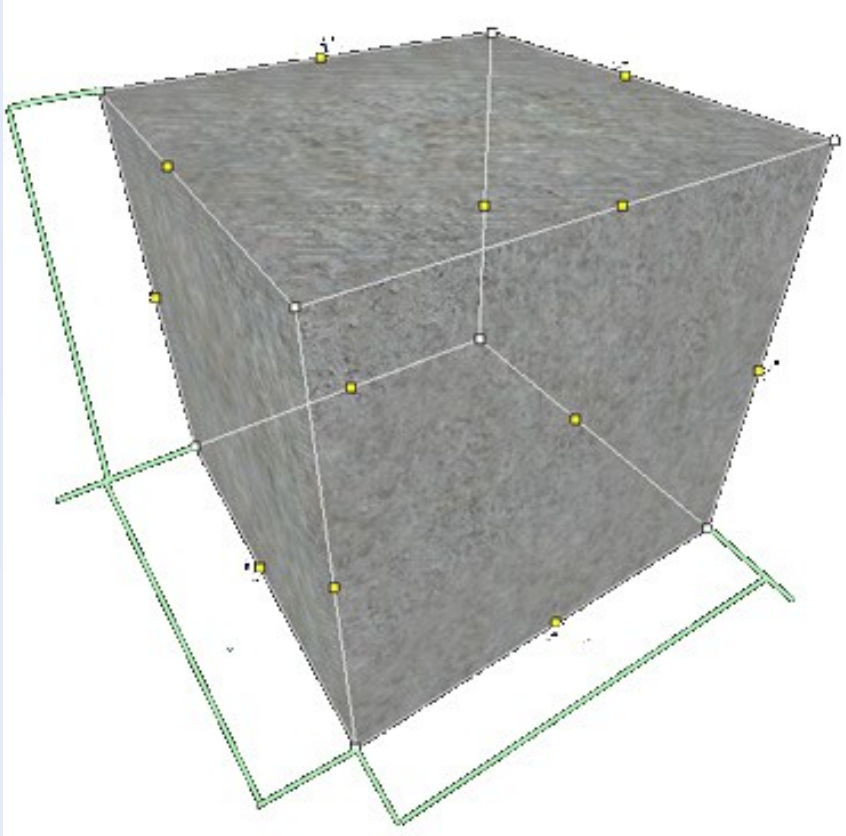
- Simulated space size X, Y, Z

- In a few points of the space added N amount of the pollutant

- Choose a point in space to get the result

- Simulate pollutant spreading at intervals t

- Visualize simulation results.

How software works

- Users connect to the cloud server using a web browser

- Users send the tasks on the server for execution.

- Users download the result file or view it in the browser
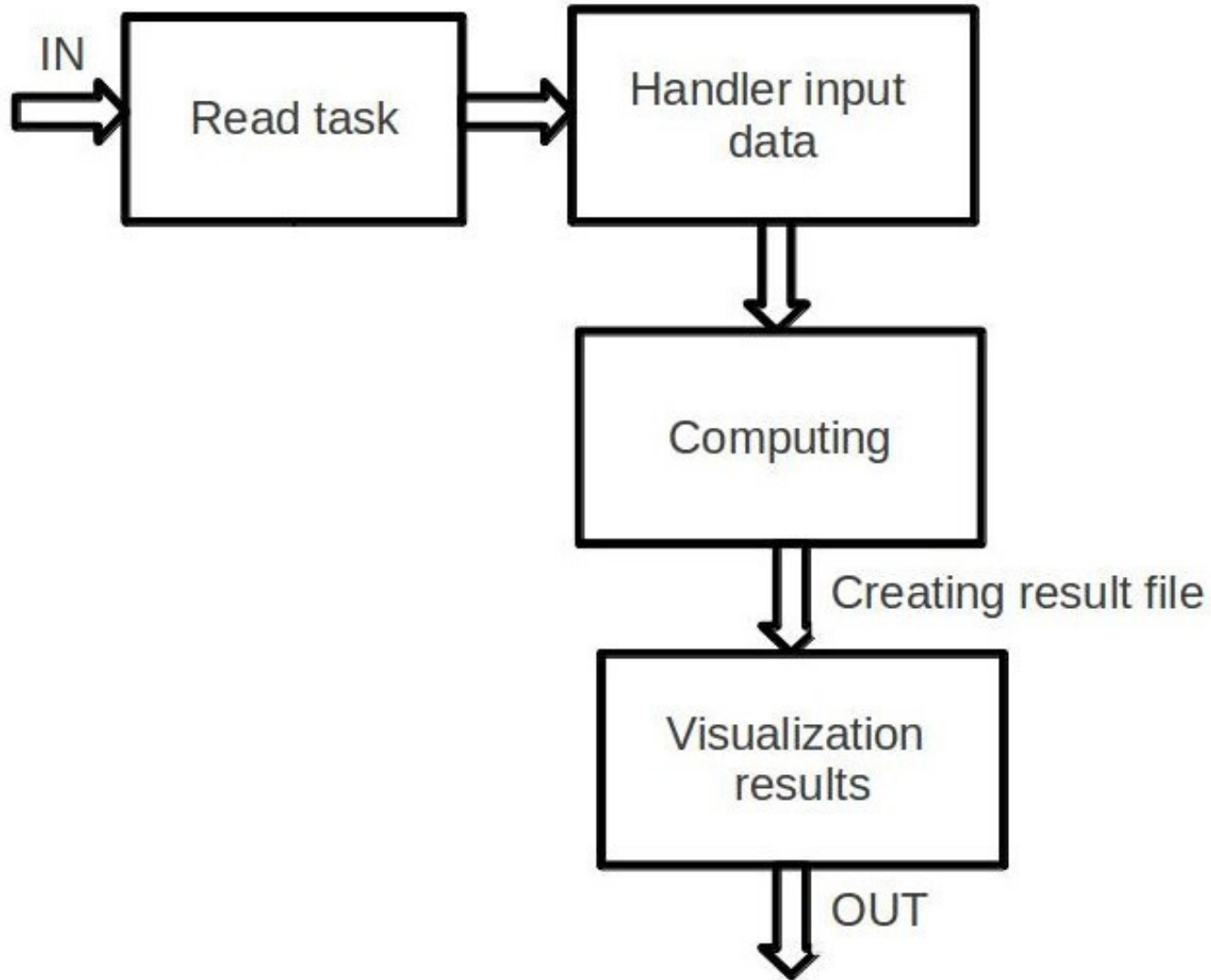
Incoming and outgoing data
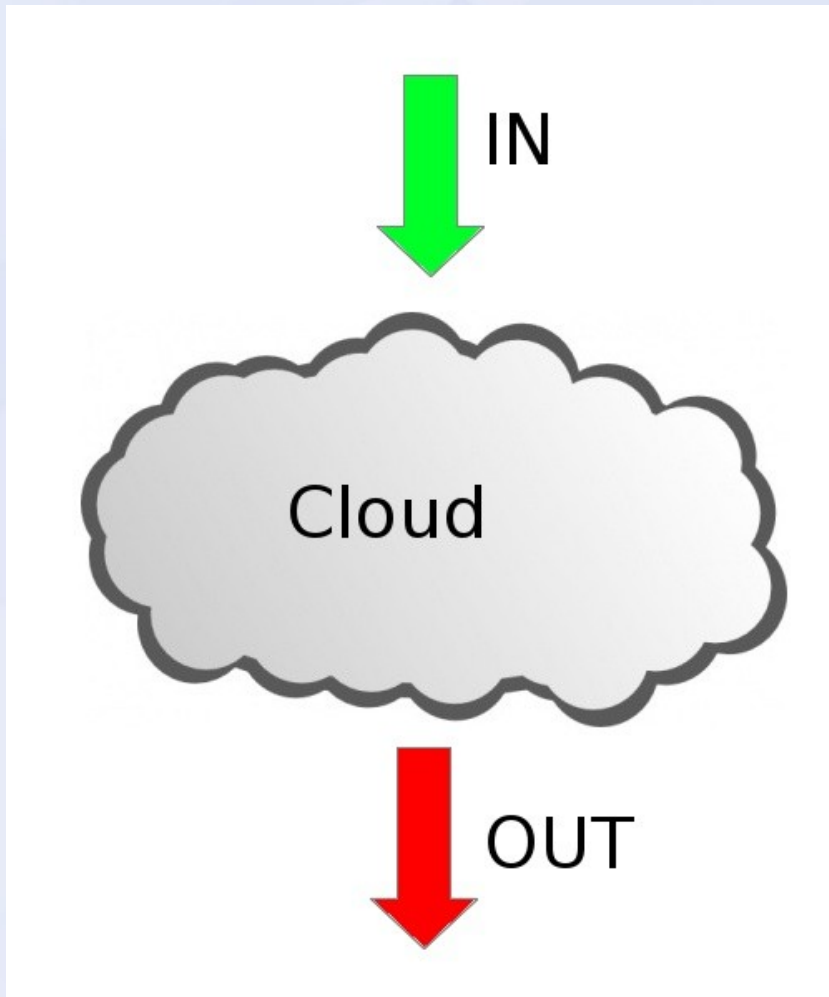
Incoming file contains:

- methods for simulation

- incoming data

Output file contains:

- the simulation results

- file for visualization

What's in the cloud?

Why cloud computing?

- The tasks of the pollutants movement simulation consume loads of CPU time.

- The ability to create a library of tasks.

- The ability to access services from any place in the world.

Novelty

- The usage of cloud computing service - as a web service for the user.

- Visualization of simulation cloud computing results of 3D graphics in the web browser.

Methods for simulation (first stage)

- The Fick's law of diffusion

- The Monte Carlo method

- Models emission and scattering gases

The Fick's law of diffusion

Fick's first law relates the diffusive flux to the concentration under the assumption of steady state. In one (spatial) dimension, the law is

$$J = -D\frac{\partial \phi}{\partial x}$$

In two or more dimensions we must use ∇, the del or gradient operator, which generalises the first derivative, obtaining

$$J = -D\nabla \phi$$

The Monte Carlo method

- Physical phenomenon is associated simulating a random process

- This process is implemented using a set of random numbers

- Calculates the probability of physical parameters with step T

Models emission and scattering gases

- This set of user models
- They are transferred to the software using API

Research work plan (1/6)

1. Simulation diffusion of substances in the atmosphere under normal conditions.

This item includes the development of software for simulation the diffusion of CO, CO2, methane under normal conditions using the Monte Carlo method and the Fick's law of diffusion. Creating task constructor.

Research work plan (2/6)

2. Visualization of the simulation results by 3D graphics.

   This item implies the development of the graphics engine to display the simulation results tasks in a browser using WebGL technology.

Research work plan (3/6)

3. Simulation of the substances diffusion in the atmosphere considering weather conditions and atmospheric physics. Connection of the weather information servers.

Research work plan (4/6)

4. Simulation of the substances diffusion in the atmosphere, considering the terrain factors and others.

Research work plan (5/6)

5. Creation an API for transfer modeling methods in software.

This item includes the development API interface for software for simulation user's task and Providing of the ability to download tasks for modeling as a single file or with the help of the task constructor.

Research work plan (6/6)

6. Providing of the secure access to the software. Creation of the tasks library.

Development tools

Server part:

- PHP, C++, MPI

Visualization of the simulation results:

- WebGL

Communication with the user

- Web browser

Conference / workshop proceedings

- M. Skrypskyj. G. Vorobets. *Cloud Computing for Simulations of Dissemination Pollutants from Industrial Enterprises* In: Scientific-Practical Conference "Physical and technological problems of radio engineering devices, telecommunication, nano-and microelectronics", pp. 153-156, Chernivtsi, Ukraine, November 2011