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IT4Innovations

National Research Center for Computing

Prof. Ivo Vondrak
ivo.vondrak@vsb.cz

Partners:

VSB – Technical University of Ostrava
University of Ostrava
Silesian University in Opava
Academy of Sciences of the Czech Republic
FIT Brno University of Technology

http://www.it4innovations.eu

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Motto:

The best way to predict your future is to create it ...

Abraham Lincoln

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The best way to predict your future is to create it ...

Abraham Lincoln

The best way to predict your future is to simulate it ...

Ivo Vondrak based on Abraham Lincoln

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Research Context

Society
- Floods Modeling and Simulation
- Air and Water Pollution
- Traffic Monitoring and Management
- Disaster Management
- ...

Industry
- Nuclear Power Engineering
- Heavy Machinery and Engineering
- Metallurgy
- Automotive Industry
- ...

Health Care
- Drug Design
- Embedded Systems for Medicine
- Biomechanics
- Signal and Data Processing
- ...

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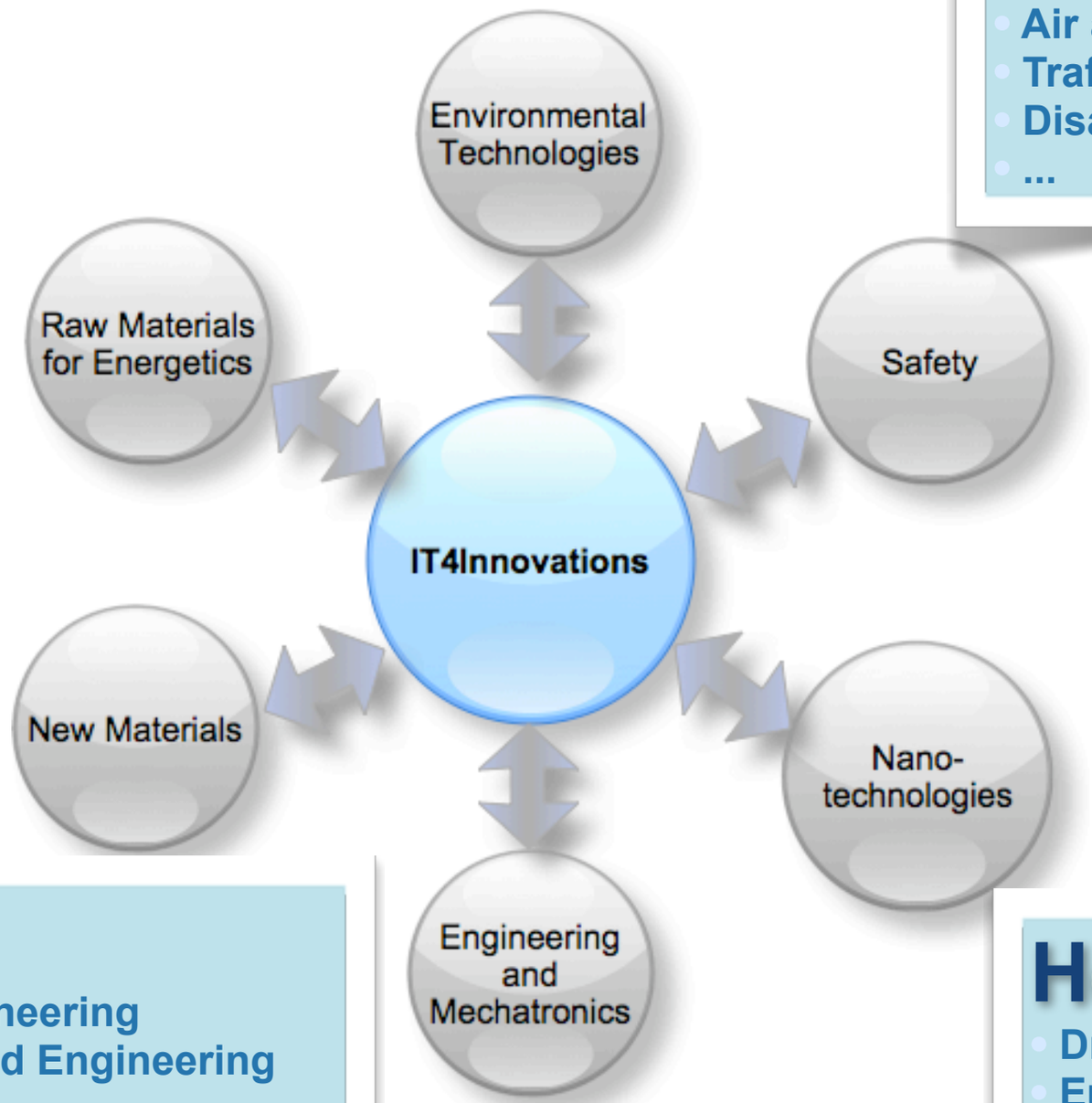

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Goals and Strategy

- The key goal is to **unify a wide range of fields of knowledge and science around the central theme of information technologies**, thus not only achieving developments in informatics and computational mathematics as such, but supporting the development of all fields involved
  - **computing.[★]; ★ = All Fields**
- The overall aim is to create a mutually interlinked, closely cooperating workplace focusing on the following 4 key areas of activity:
  - **IT4People** (Information Technology for People) focusing on improving quality of life in society via the development and provision of new services based on modern information technologies.
  - **SC4Simulations** (Supercomputing for Simulations) focusing on supercomputing and research into the development of new methods and algorithms of computational mathematics with subsequent application in multidisciplinary simulations (stress and deformation analysis of complex systems, shape optimization, fluid flow problems, material design, biomechanical simulations, drug design, etc.).
  - **EC4Innovations** (Embedded Computing for Innovations) focusing on the research and development of sophisticated embedded systems applied in mechatronics and innovative medicine.
  - **Theory4IT** (Theory for Information Technology) focusing on basic research into the development of new and non-traditional computing methods, based on disciplines such as softcomputing, formal methods, knowledge-oriented and biologically motivated algorithms.

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Research Organization

IT4Innovation R&D

Applied and Basic Research

Basic Research

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Research Organization

IT4Innovation R&D

Applied and Basic Research

- **IT4People**
  - IT4Distaster Management
  - IT4Economy
- **SC4Simulations**
  - SC4Industry
  - SC4Natural & Biosciences
  - SC4Nanotechnology
- **EC4Innovations**
  - EC4Industry
  - EC4Innovative Medicine

Basic Research

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Research Organization

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Basic Research

- **Theory4IT**
  - Softcomputing4IT
  - Knowledge4IT

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Supercomputing Center

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Research Organization

IT4Innovation R&D

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Supercomputing Center

eInfrastructure

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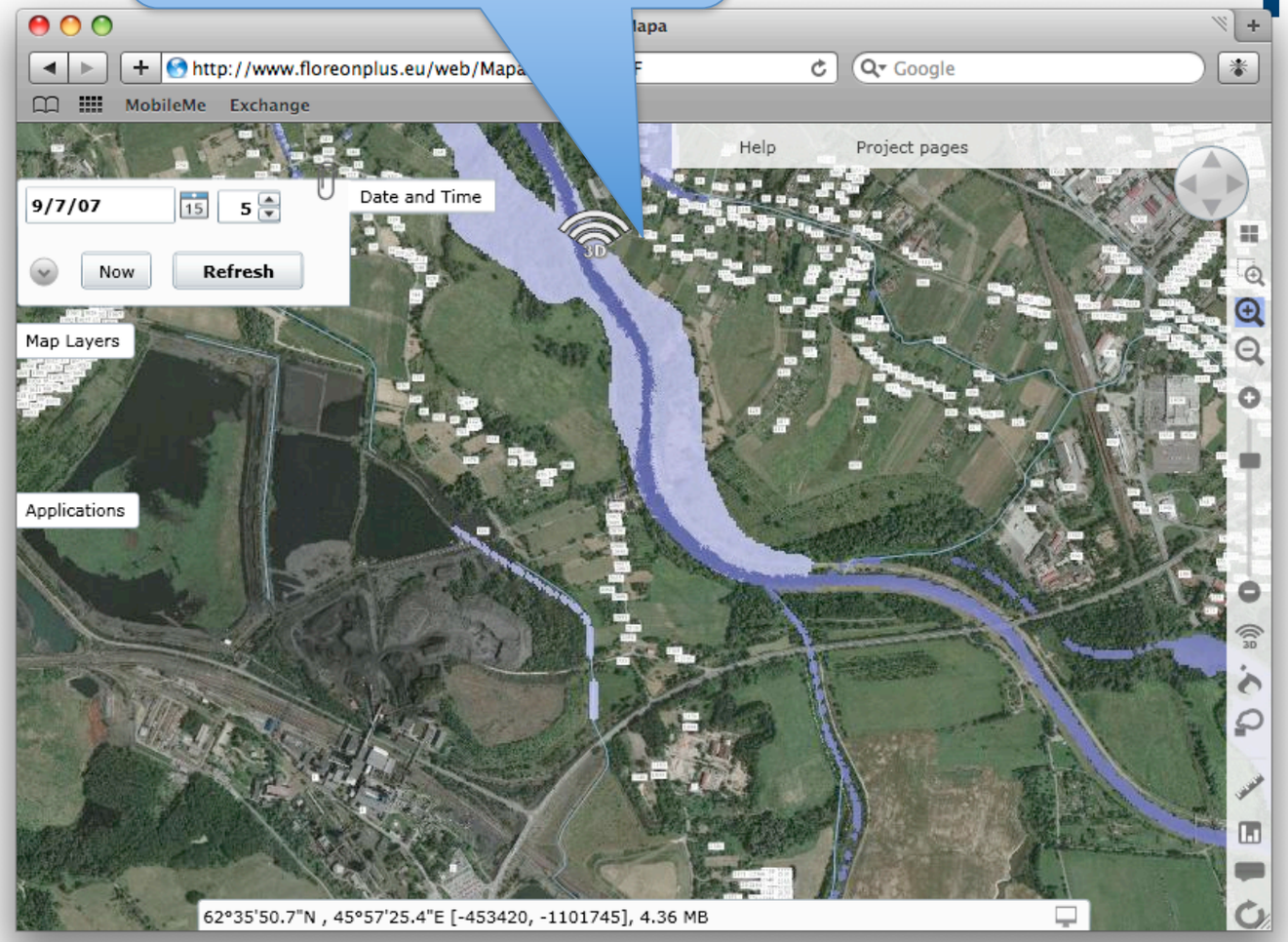
Research Activities

Research Activities Structure	Research Team	IT for People		Supercomputing for Multidisciplinary Simulations			Embedded Computing for Innovations		Theory for IT	
Research Activity		IT for Disaster and Traffic Management	IT for Economy	Supercomputing for Industry	Supercomputing for natural and biosciences	Supercomputing for Nanotechnologies	Embedded computing for Industry	Embedded computing for Innovative Medicine	Soft-computing	Knowledge systems for IT
Applied Resesarch										
Activities:	Modern software architectures	provided by					used by	used by		
	Data integration and warehousing	provided by	used by	used by	used by	used by			used by	used by
	Data security	used by	used by							provided by
	System modeling and simulation	provided by	provided by	provided by	provided by	used by				
	Mobile and embedded systems	provided by					provided by	provided by		
	Visualization and image recognition	provided by		used by	used by	used by				
	Voice and speech recognition	provided by					used by	used by		
	Control systems						provided by	provided by		
Basic Research										
Activities:	Data processing	used by	used by	used by	used by	used by				provided by
	Knowledge management	used by	used by							provided by
	Biologically inspired algorithms	used by	used by		used by	used by	used by	used by	provided by	provided by
	Verification and complexity	used by					used by	used by		provided by
	Processing of uncertain information		used by				used by	used by	provided by	
	New algorithms for parallel computing	used by		provided by	provided by					
	Molecular modeling and design					provided by				
	Modeling of nanostructures					provided by				

IT4People

Floods modeling and simulation
(web-based, virtual reality …)
www.floreonplus.eu



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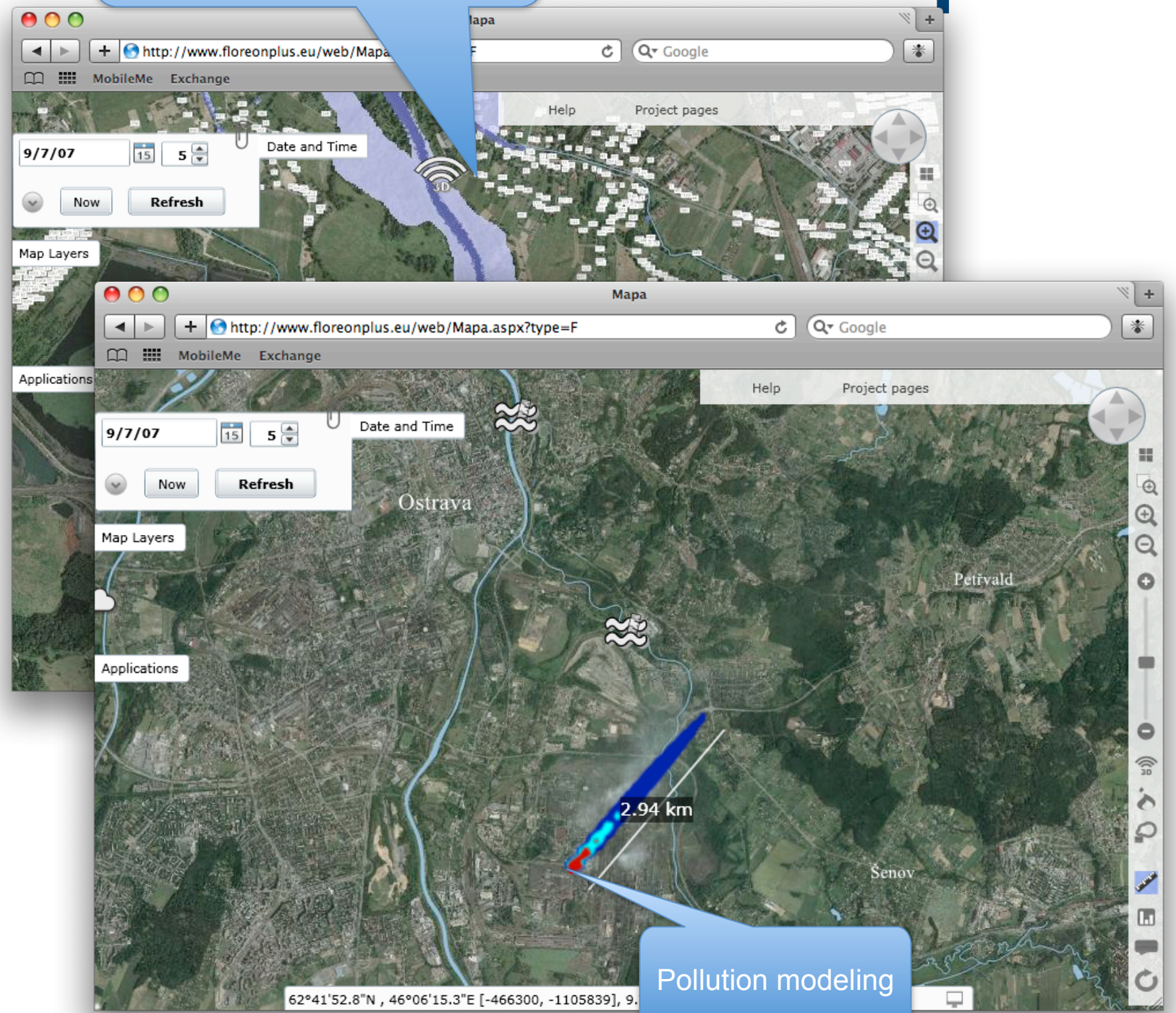

Pollution modeling

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IT4People

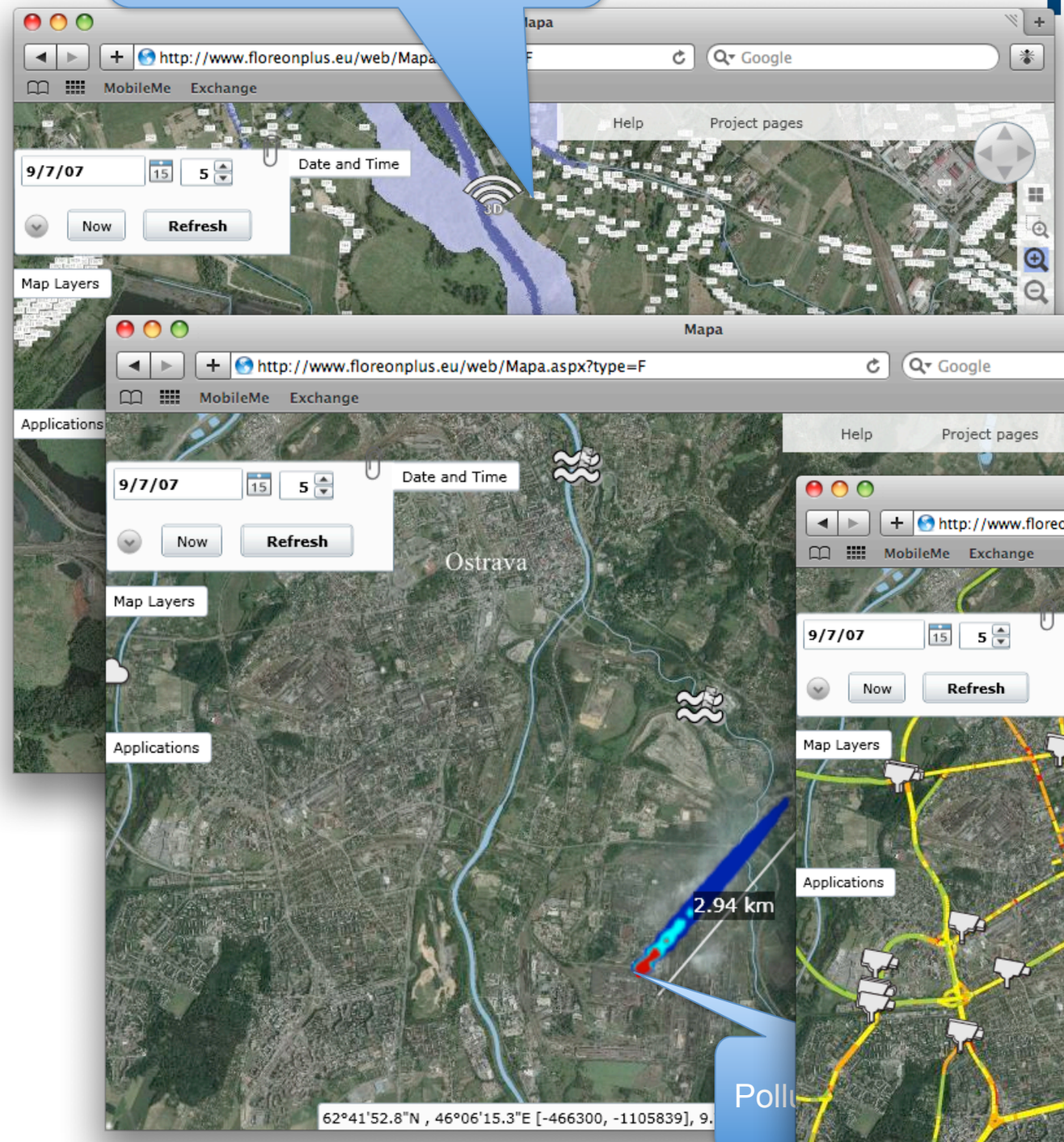
Floods modeling and simulation
(web-based, virtual reality …)
www.floreonplus.eu

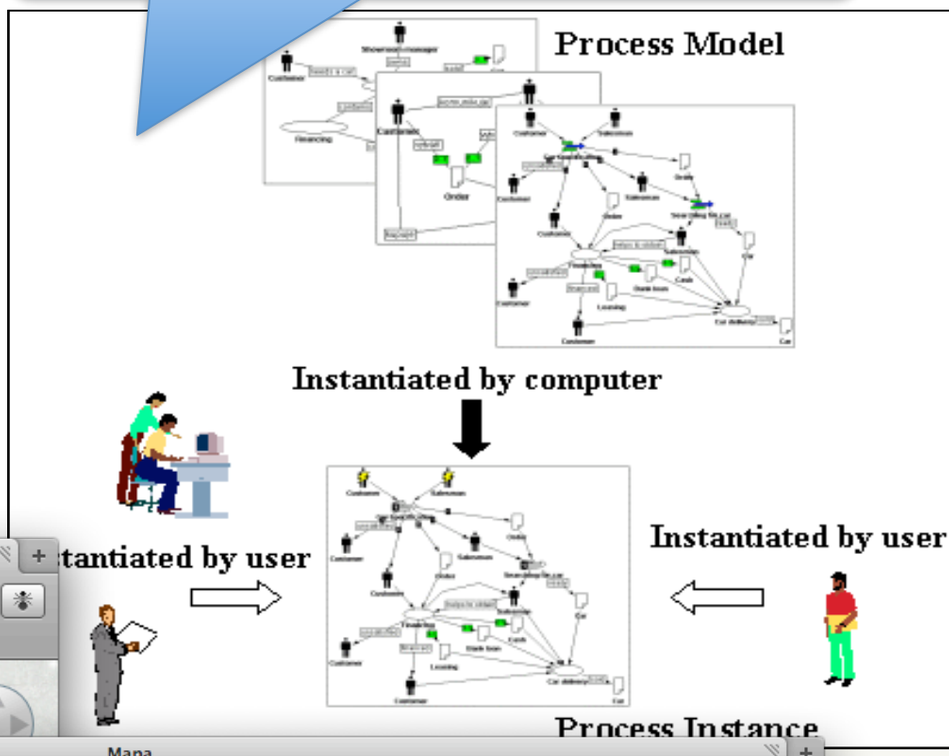
Traffic monitoring and prediction
(GPS-based tracking, …)

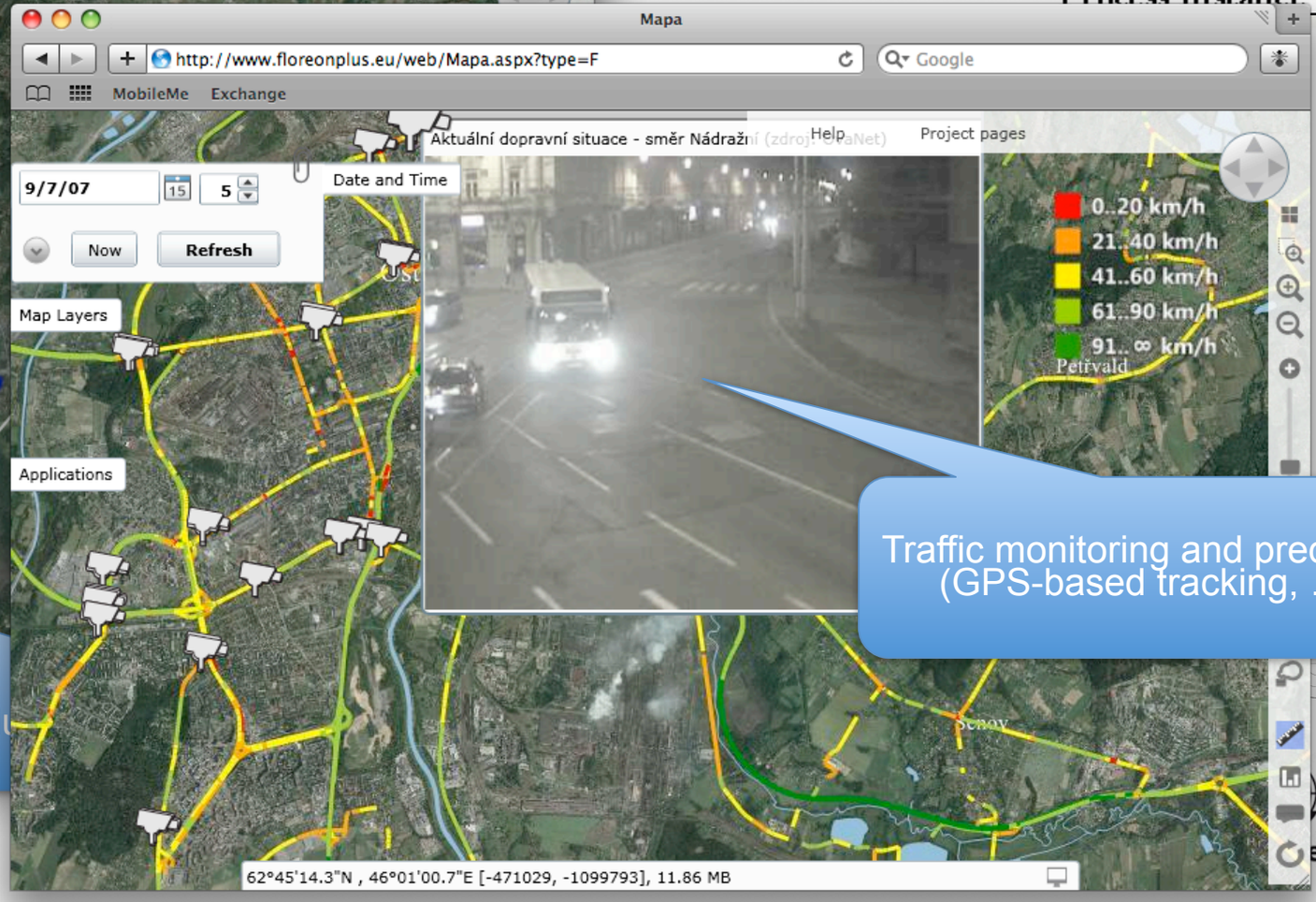
IT4People

Floods modeling and simulation (web-based, virtual reality …) www.floreonplus.eu

Process modeling, simulation and enactment for disaster management







Traffic monitoring and prediction (GPS-based tracking, …)

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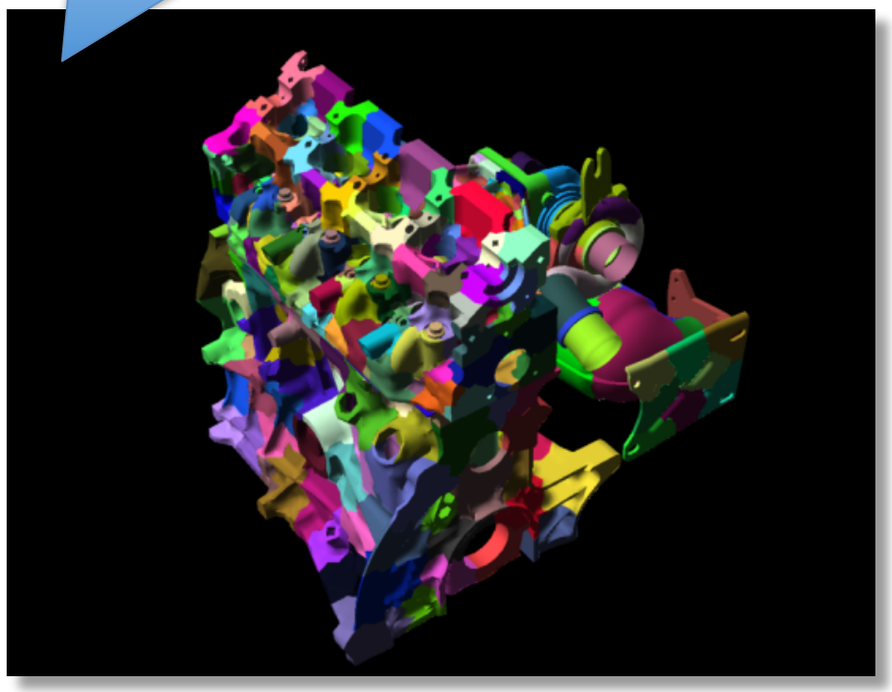
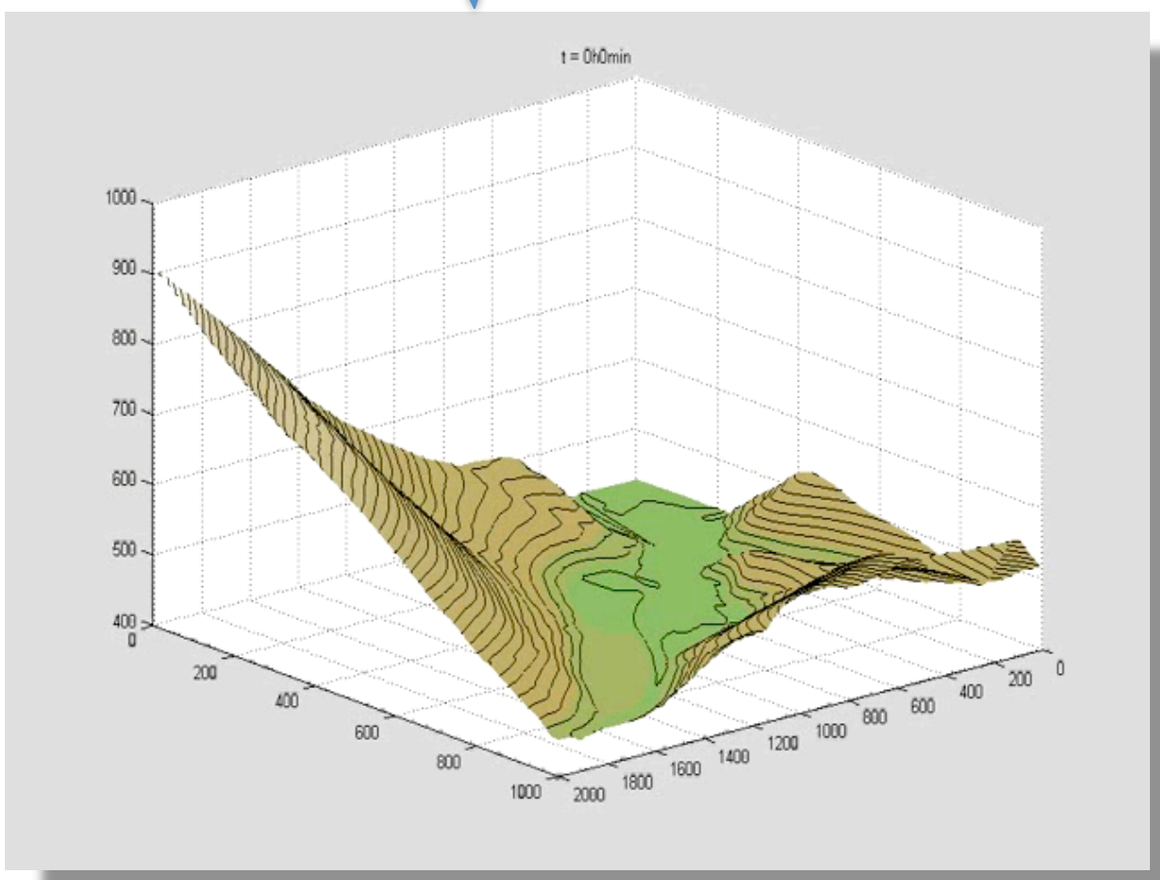
SC4Simulations

Loading of Formula 1 engine using domain decomposition algorithms developed at our university



Flood wave simulation using 2D models



Modeling and simulation in biomechanics

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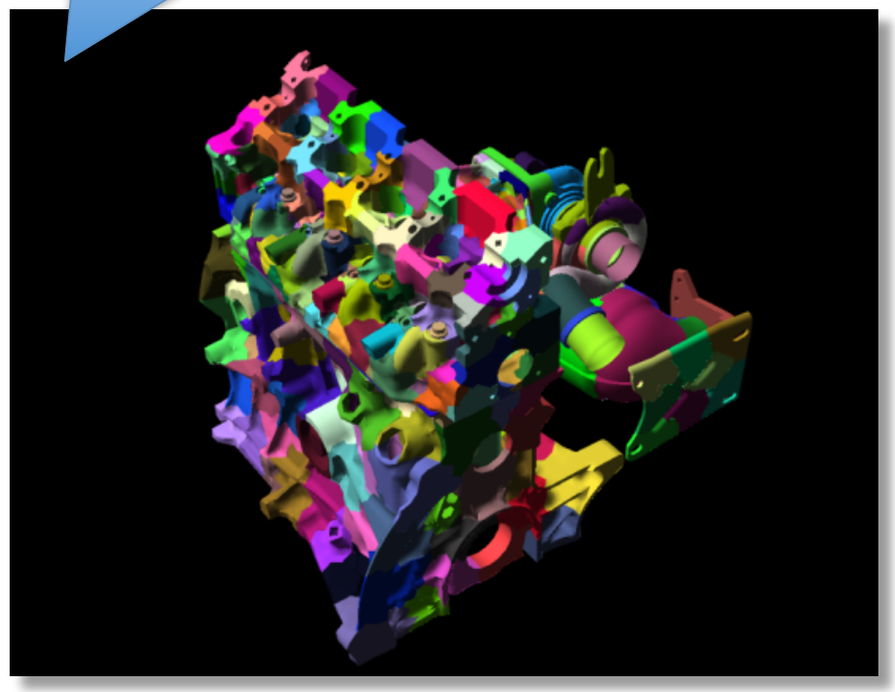

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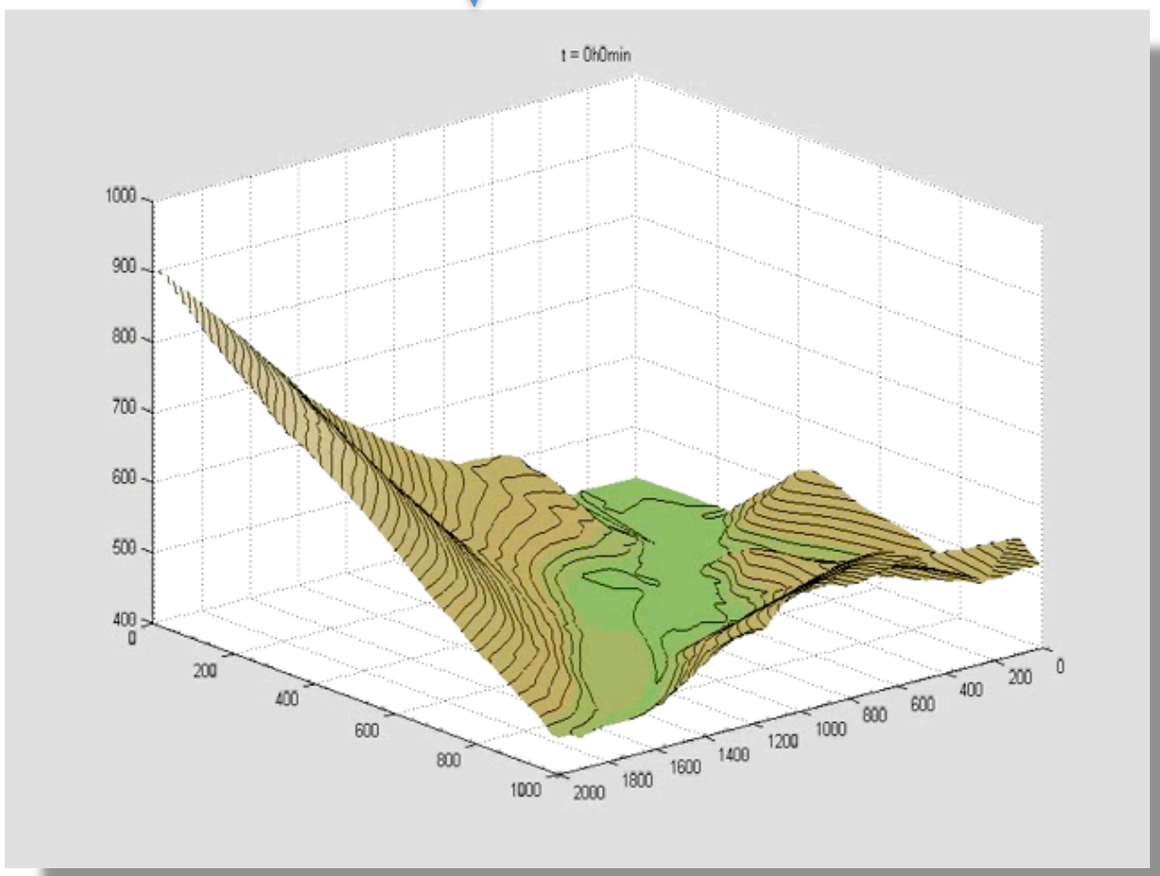

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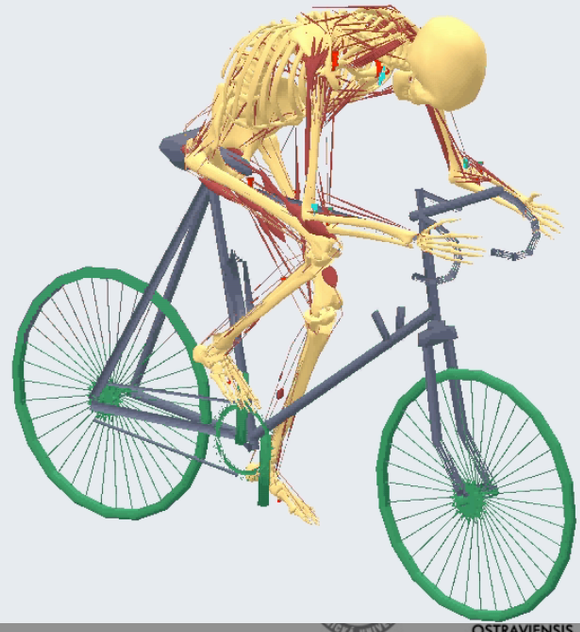

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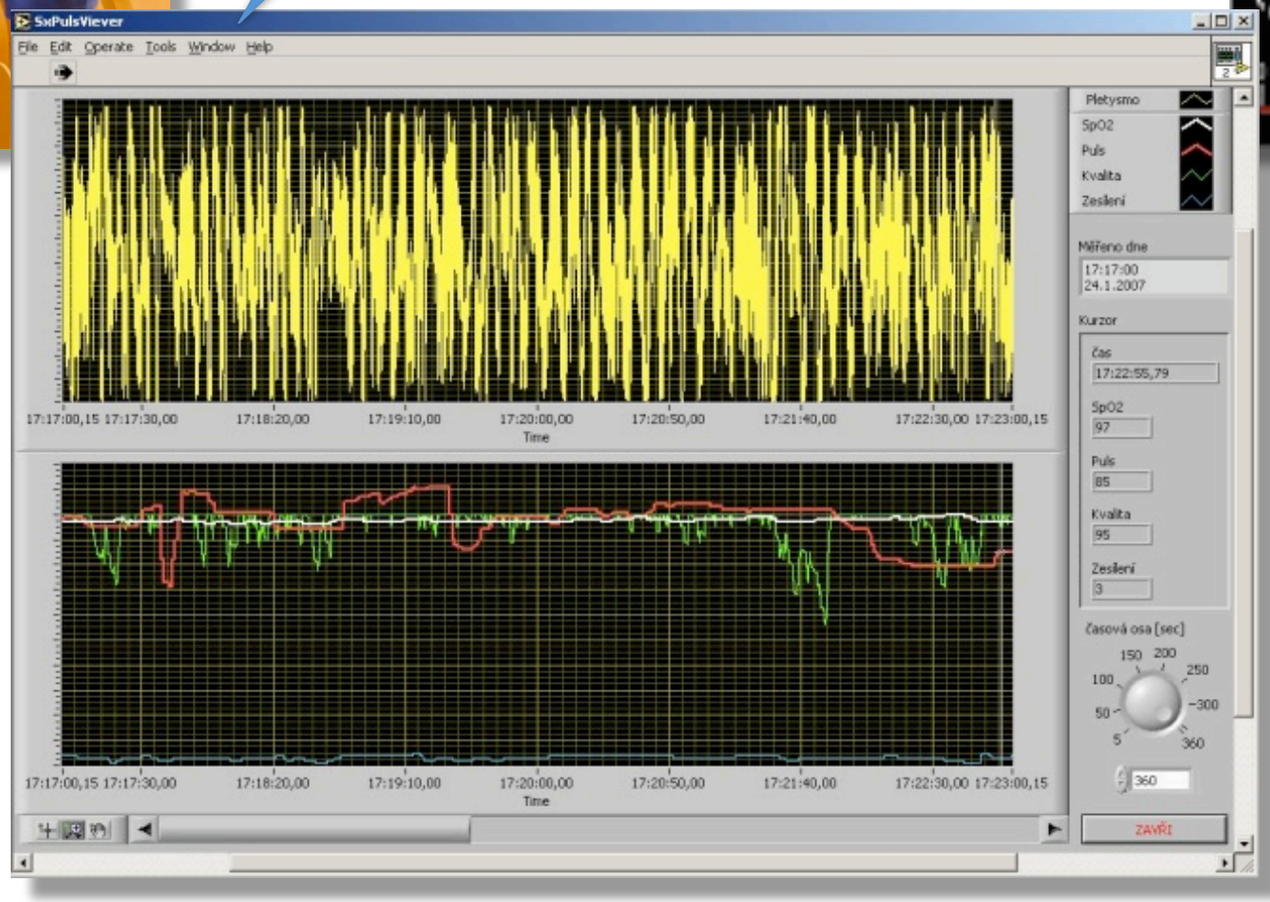
Measurement and evaluation of biomedical signals



Control System for Ultralights

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Theory4IT

- The goal of the project in activities related to the development of theory (IT4Theory) is to carry out research focusing on mathematical theories of modern computation methods in the following five key areas:
  - **Softcomputing4IT** (Softcomputing for Information Technology):
    - research of mathematical principles and methods of processing knowledge burdened with uncertainties and their use in the development of methods and technologies applicable in decision-making, management, complex systems design etc.
    - research of strategy and cooperation in multiagent systems.
  - **Knowledge4IT** (Knowledge Systems for Information Technology):
    - research and development of modern methods used in software engineering and data management,
    - research of algorithms inspired by biological models (evolutional and genetic algorithms, ant colony theory, neural networks, etc.),
    - research of knowledge mining and the development of special data structures for storage of extensive collections of weakly structured data.

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Costs Estimation

- **Budget**
  - 1. Construction-related Investments: 600 mil. Kč
  - 2. Equipment costs: 1 000 mil. Kč
  - 3. Start-ups: 400 mil. Kč
  - ----------
  - TOTAL: 2 000 mil. Kč

- **Main Investments:**
  - New premises for supercomputer center 400 mil. Kč
  - Supercomputer 700 mil. Kč

- **Operations costs (2016 and on): 300 mil. Kč/year**
  - 25 - 35% of these costs will be covered from application sphere

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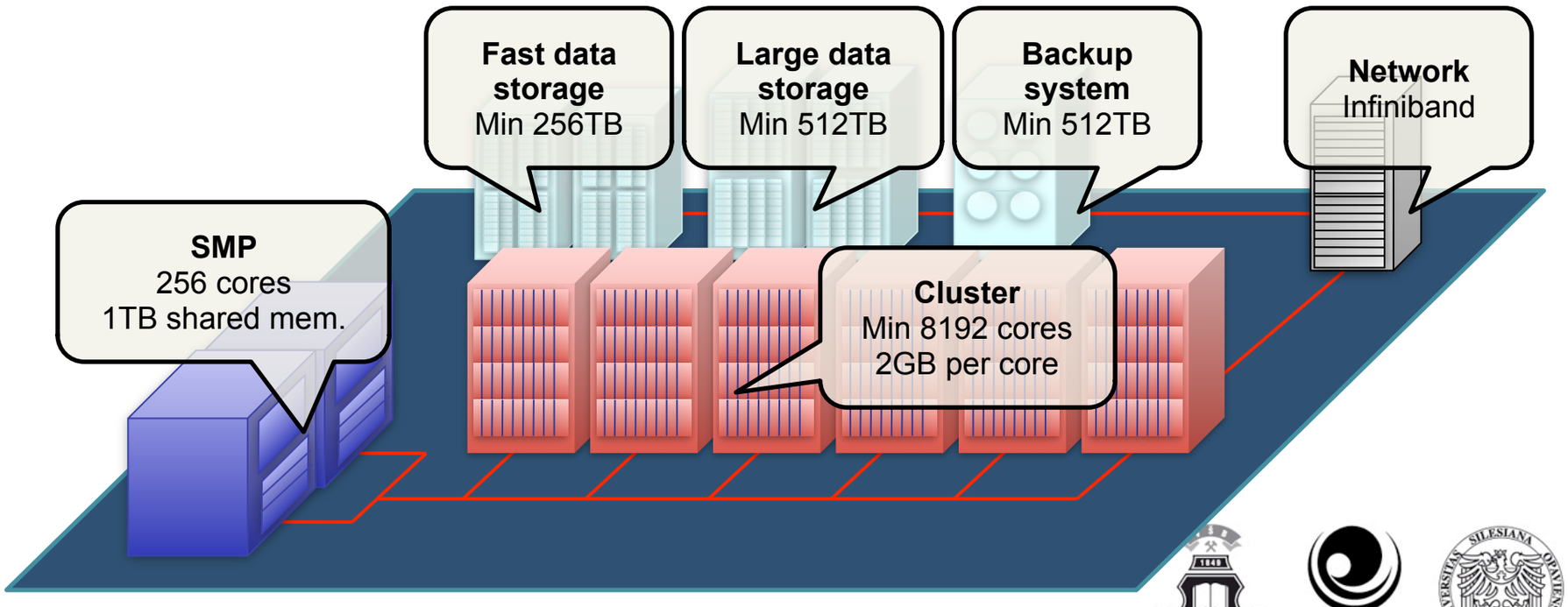
Supercomputer Center

- Development Software
  - Netlib (Linpack, Lapack, Atlas, …)
  - MPI, PETSc.
  - Matlab + Simulink
  - OOSol, MatSol (Our own libraries)
- Application Software
  - CAD (Catia, NX, ProE, ANSA, OrCAD …)
  - FEA (ANSYS, ABAQUS, MsC, Comsol, Fluent, CFX …)
  - Others: ESRI, FEFLOW, MODFLOW, Witness, SPSS
- Hardware Configuration



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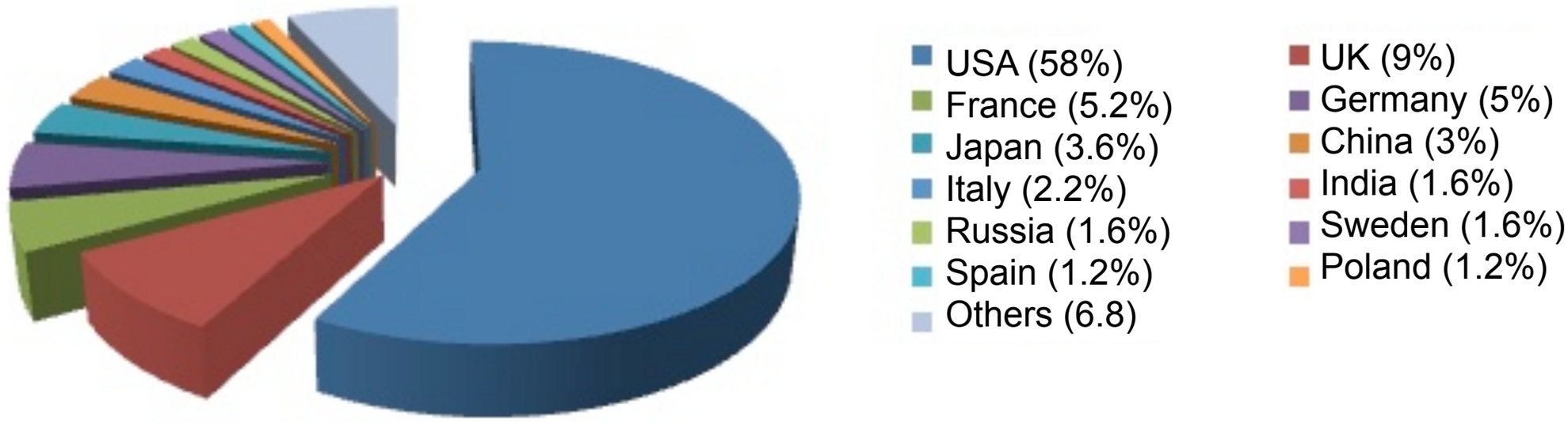
Why do we (Czech Republic) need supercomputer?!

- **Research in new technologies and supercomputing simulations cannot be separated**! Right now Czech Republic has no supercomputer in TOP500:



- Simulations in disaster management require to compute large number of numerical experiments in a very limited time! The only option is execute such task in parallel and to employ sophisticated algorithms for their coordination.

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Main Characteristics of the Center IT4I

- **Personnel: 200 employees (= 130 FTE)**
  - 20 management positions, jobs in services, and systems administration.
  - 80 research positions
    - Key senior researchers connecting the computer science/technical side and the application/scientific side)
  - 100 doctoral candidates and postdocs
- **Open access** for external partners from academia and industry
  - Project proposal shaped according their needs – survey planned
  - Promised cooperation: Integrated Safety Center, Visteon-Autopal, Vodafone, Saab Group, Vitkovice, Faculty Hospital in Ostrava, CESNET, IVAX, ITCluster, …
- Increasing demand for and skills in (super)computing by **education and training** in scientific computing (e.g. summer schools)
- IT4I as a **national HPC center** cooperating with European SC centers (relations to PRACE project partners)

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Web Pages

- www.it4innovations.eu
- www.it4i.eu
- www.it4innovations.cz
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