Global Interdisciplinary Research
Challenges for IT
INRIA: French Research Institute in Computer & Information Science & Engineering

- 150 research groups in
  - *Modeling*, control and applied mathematics
  - *Programming*, secure and reliable IT
  - *Communicating*, networks, systems, grids
  - *Sensing and interacting*, vision, graphics, VR and robotics
- A total work force of 3600 persons
  - 1100 researchers and faculty members
  - 1500 doctoral candidates and post-docs
    in 8 research centers in France with wide involvements in Europe
- A consolidated budget of 250M€
Challenges for global interdisciplinary IT research

- Pervasiveness of information technology
- Emerging research areas and new domains for global IT research
- Barriers to successful collaborations and how to overcome various obstacles

Focus on emerging research areas in
- Computational Engineering
- Computational Sciences
Pervasiveness of IT in Engineering

- Every manufactured object or system exists numerically before existing physically
- *Virtual prototyping* for the design of
  - More demanding functionalities, with models ranging from the physical to the sociological levels
  - More challenging properties: safety, reliability, life cycle management
  - Reduced time and costs for designing, manufacturing, using
- More and more artifacts do include capabilities for sensing, communication, processing, and *interaction with other objects*
IT Challenges in Computational Engineering

- Computational tools for modeling and design
- System architecture
- Software synthesis, validation and verification
- Safety and security
- Life cycle, supervision, diagnosis, reconfiguration
Global research in Computational Engineering

An area for global research:

from *interoperability* to *intelligent interactions*

in an open-ended space of objects and services

- Objects should be able
  - To disseminate useful models of how they work, the services they may provide, and their constraints and capabilities
  - To read, understand and make use of an open set models of other objects they may need to be interfaced with

- Example: Integrating the Healthcare Enterprise, *Connect-a-thon*

- Challenge: moving from exchanging data → metadata → models of selves
Pervasiveness of IT in Science

- *Homogeneous* analytical models remain limited for addressing complex domains
- Computational models allow the *integration* of heterogeneous mathematical representations, multi-physics and multi-scale models
- Improved and wider sensing capabilities allow for the collection of large amount of data
- Algorithms and processing capabilities for
  - Data-assimilation, estimation, learning and model qualification
  - Simulation and *in silico* experiments
  - Visualization, palpating models and data
- New paradigms for modeling and experimenting
Computational Sciences

- Computational material
Computational Sciences

- Computational material
- Computational cells
Computational Sciences

- Computational material
- Computational cells
- Computational organs
Computational Sciences

- Computational material
- Computational cells
- Computational organs
Computational Sciences

- Computational material
- Computational cells
- Computational organs
- Computational plant and ecology
Computational Sciences

- Computational material
- Computational cells
- Computational organs
- Computational plant and ecology
- Computational environment and biosphere
IT Challenges in Computational Sciences

- Integration of models over
  - Heterogeneous representations: continuous, discrete, deterministic, stochastic, geometric, topological, combinatorial
  - Wide spectrum of scales

- Libraries of computational models

- Data assimilation and learning

- Qualification of data, models, and predictions

- Visualization and interaction
Areas for global interdisciplinary research

- Large scale networks for observing, sensing, collecting and data organizing for mining and querying
- Libraries of inter-operational models
- Wide access to predictions, visualization, scenario definition and simulation

=> Towards *popular sciences*

- An example: International Thermonuclear Experimental Reactor