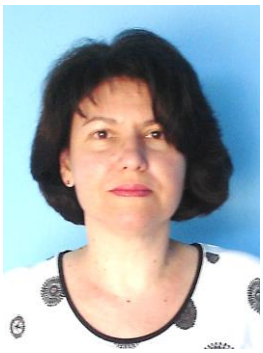
Prof. Anca Daniela IONITA



PhD Coordination in Systems Engineering

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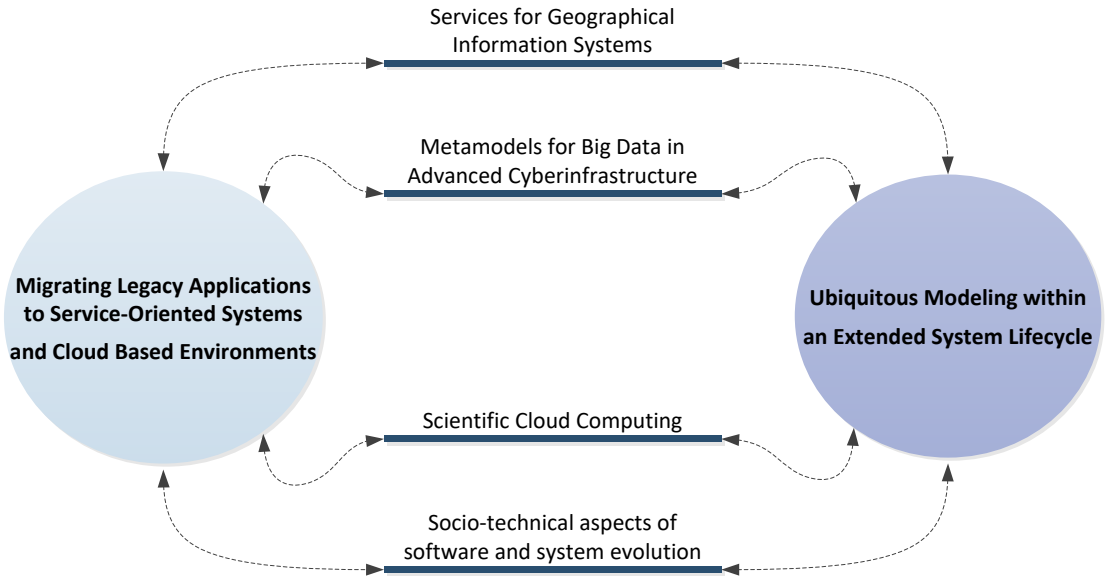
My research agenda for PhD coordination is organized around four important topics:

Services for Geographical Information Systems
Metamodels for Big Data in Advanced Cyberinfrastructure
Scientific Cloud Computing
Socio-Technical Aspects of Software and System Evolution



Services for Geographical Information Systems

Geographical Information Systems are largely used for acquiring, integrating, processing and visualizing data and information related to infrastructures with a large distribution degree, for a variety of application domains, like natural resource management, or radio-nuclear and chemical vulnerabilities induced by small and large entities, either industrial or governmental. These systems are based on a highly non-homogeneous acquisition of data, from existing databases, manual measurements, sensor networks, public websites etc. and are based on complex visualization facilities, overlapped to various maps, which may be stored locally or remotely, in a Cloud environment. Apart from this, the data analysis should be capable to offer

relevant inputs for complex decision systems, based on artificial intelligence and formal representation of knowledge, in order to indicate the appropriate moment and the receiver of early warning messages.

The challenges are related to the adoption of proper platforms, like ArcGIS, and integrating the services supported by them with legacy software for processing domain specific data and for applying mathematical models of high complexity. Besides, an important aspect is the necessity to offer awareness and early warning services for various territorial vulnerabilities (e.g. induced by chemical or radio-nuclear pollution) and to design a trustful decision support system, with rules that lead to transparency and communication speed, yet they also conform to the constraints imposed by the organisms officially entitled to manage emergency situations.

Metamodels for Big Data in Advanced Cyberinfrastructure

The characteristics of cyberinfrastructure lead to the necessity to integrate large scale data originated from different sources and geographical locations, and to assure high performance computing for processing them, involving challenges typical to Big Data. The resulted repositories have to be well-organized and, moreover, one should be capable to manage and analyze data in a meaningful way, through tools that are easy to use for specialists from the application domains. This led to a new trend called “extreme data”, where organization and processing are equally important.

The existing systems for integrated laboratories are focused on automation and integration of data acquired from various devices; both raw data and those resulted from a primary processing are taken into account. This integration may be done under a LIMS (Laboratory Integrated Management System) - representing an industrial solution that optimize laboratory productivity. However, many laboratories are confronted with the problem of a high non-homogeneity of existing apparatus, equipment, tools, standards and producers, situation that is not efficiently handled by existent LIMS, irrespective of their provisioning model.

In this context, my intention is to continue the research related to metamodels and tools for data integration, and to extend the language defined for modeling measuring instruments for covering a larger spectrum of acquisition systems, including sensor networks, with a graphical representation of the topology and export/import facilities to existing standards. We have to find a solution for elaborating data models in a sustainable way; therefore, experts in an application domain should be able to define models by their own, without any help from a software engineer. For this reason, it is not appropriate to use a general modeling language and it is necessary to define a small, specific language, based on the concepts familiar to the experts in metrology. An important challenge in data integration is also semantics, e.g. correspondent elements can have similar names but different semantics, or vice-versa. This research can benefit from the experience gained in CyberWater, where the acquisition system leads to the accumulation of large-scale data about the river flow properties indicating the water quality.

Scientific Cloud Computing

Cloud Computing environments represent a possible solution for the deployment of applications based on large scale data. Virtualization and elasticity have become a vital necessity, along with the involvement in delivery of products and services with potential use at national level, characterized by a strong unpredictability of the load, and demanding a high dependability, essential for enterprises and also for the governmental reputation.

Software as a Service should be developed for organizing, storing and retrieving non-homogeneous data, including advanced facilities for: importing data formats specific to various sources, irrespective of their complexity and diversity; exporting to standard formats for a large spectrum of data processing tools; migrating existing data storages, i.e. various files directories and databases. The research should be oriented towards the realization of:

- a metamodel capable to characterize a large spectrum of data sources and generic for the entire metrology domain scale;
- mature tools for supporting this metamodel as a modeling language specific to the metrology domain, including editors, validation utilities, complex model transformers;

The research on Cloud Computing will also be aligned with the trends discovered in the organization of MESOCA, IEEE International Symposium on the Maintenance and Evolution of Service-Oriented Systems and Cloud-Based Environments.

Socio-Technical Aspects of Software and System Evolution

The migration of traditional data management systems towards modernized solutions, based on metamodeling, Service-Oriented Architecture and Cloud Computing, does not only imply technological challenges, but also transformation at the level of stakeholders, roles, psychological implications, organizational structures.

My research agenda intends to approach this situation from the point of view of creating new languages and tools for a better visualization of the human aspect of the evolution, and for developing new rules, analysis methods and decision support facilities. This may also affect the way one models and treats security access roles to the new systems, characterized by the integration of multiple artifacts at a high level of abstraction. It represents an aspect of the migration that has been ignored so far, and has to be introduced in the future tool suites, along with the support for business assessment, risk management, reengineering and model-driven engineering.

Although this research has been initiated by coordinating students' research activities, and a case study was performed for the CyberWater system, the work can only be fulfilled through a systematic collaboration with specialists in human resources and in large organizations based on service provisioning, for increasing the generality of the solution and validating the results.

Future work related to the tools for modelling human aspects of software evolution may be oriented towards:

- developing model interpreters for business analysis and organizational restructuring recommendation;
- integrating the modelling tool in a business process management suite;
- replacing the paradigm for SOA roles with one representing another kind of modernization (e.g. migration to Cloud Computing environments), while reusing the other two paradigms;
- supporting the composition with a qualifications' ontology for mapping people to positions based on semantic criteria;
- integrating the organization change modelling into a methodology and a tool suite for migrating legacy applications to service-oriented systems;
- composing the defined roles with access rights models for enterprise security systems.