STARTPAGE

HUMAN RESOURCES AND MOBILITY (HRM)
ACTIVITY

MARIE CURIE ACTIONS
Research Training Networks (RTNs)

PART B

"NUMAS"

B1 Scientific quality of the project

B1.1 Research topic

To compete in the new global market, European industry must take advantage of the competitive edge that would be gained from using European expertise in applied mathematics and scientific computing. Engineers, applied scientists and mathematicians working in industry can greatly benefit from close collaboration with academics and mathematicians with skills and knowledge relevant to their applications. Moreover, there is a shortage of mathematicians within European industry, particularly in the sectors of numerical mathematics and statistics. Thus, there is the need for a new action to bring industry up to date with the state-of-the-art mathematical ideas, methodologies, tools and techniques. Academic resources in Mathematics for Industry are also scarce and fragmented across Europe, while industrial needs are widely spread. Exchange and interaction are necessary in training, research and industrial arenas.
We have recently had the opportunity to contact several colleagues working for institutions participating directly in ERCIM (European Consortium for Informatics and Mathematics). The need to build up stronger links between the mathematicians within ERCIM and the Universities stimulated the creation of the two Working Groups “Application of Numerical Mathematics in Science” and “Mathematics and Statistics”, where a cross fertilisation among the numerical techniques used in different fields of scientific computing could take place.
These Working Groups have decided to submit this joint proposal for the creation of a “Marie-Curie Research and Training Network” aiming to become an international leader and a reference point within Europe on this underpinning theme of computational mathematics.
A survey among the active researchers in the laboratories of the Organisations that participate in the Network, indicates that the following major fields have strategic interest:

1. Numerical Linear Algebra;
2. Numerical Solution of Differential Equations;
3. Continuous Optimization and Optimal Control;
4. Computational Statistics;
5. Statistical Applications;
6. Large Scale Scientific Computing.

Each of the fields frequently uses techniques developed in one of the others. By creating a network of European researchers, the increased collaboration and communication between the fields will further strengthen this research and enhance its impact on science and industry.

B1.2. Objectives of the Network

The global aspiration of the network is to link together mathematicians working in the National Laboratories, the Universities, and the R&D groups in Industry.
We now briefly describe the specific topics of research in each field.

- **Numerical Linear Algebra**. The topics range from sparse matrix theory, direct and iterative

solvers for large and sparse linear systems of equations, least-squares and total least-squares problems, to the computation of eigenvalues, eigenvectors, singular values and singular vectors for large-scale and /or structured matrix problems, including the use of symbolic manipulation techniques for the solution of polynomial systems of equations.

- **Numerical Solution of Differential Equations**. The topics of major interest are finite-element methods, mesh generation, multigrid methods, wavelets, spectral methods, and time-stepping methods.
- **Continuous Optimization and Optimal Control**. The topics of interest are interior point methods for large-scale linear, quadratic and nonlinear programming and SQP methods for non-linear programming and optimal control.
- **Computational Statistics**. The topics of interest are related to the following application fields: model selection, outlier's detection, regression diagnostics, linear and nonlinear model estimation, error analysis and error propagation, error-in-variables modelling, correspondence analysis, principal components analysis, cross-validation, Bayesan inference, Markov chains, and Monte Carlo methods.
- **Statistical Applications**. The topics of interest overlap those of the previous section, but here one focus is on statistical signal processing, statistical communication, econometrics, quantitative finance, data mining, chemometric, and biomedical applications.
- **Large Scale Scientific Computing**. In this interdisciplinary field, the topics of interest include many of those cited in the previous sections. Parallel and grid computing, and mathematical software should be added to them.

Within these fields, we have identified some integrated actions around which we can propose an interdisciplinary programme of research that will integrate the current activities focusing them on a common interest "kernel" target. In particular, we have identified among all our research topics the following transversal research lines as scientifically relevant for our cross fertilization project:

1. **Saddle points** - The computation of saddle points is a key problem in many fields. Several participants in the existing Working Groups are already studying this problem in the context of different applications, thus building multiple perspectives for its handling and solution. These applications include mixed finite-element approximation of partial differential equations in elasticity and fluid dynamics, interior point and SQP algorithms for optimisation, the solution of weighted least-squares problems, and the modelling of statistical processes. Parallel computing can be the only way to approach the solution of these problems where the number of parameters to determine is exceedingly large.
2. **Computational Statistics** - Computational Statistics requires solving exceptionally large eigen-problems and some of the largest least-squares problems in term of number of parameters. Animal breeding and data mining are two familiar examples. Latent Semantic Indexing (LSI) techniques for the latter problem, for instance, might require the computation of (partial) sigular value decompositions of matrices of order 10^8. Another kernel is the eigenvalue problem, that we know is of great interest to a large cross section of the participants of the current Working Groups. Its solution involves the study of efficient numerical algorithms, and applies to areas ranging from stability studies for differential equations to singular value decomposition in computational statistics and information retrieval.
3. **Perturbation analysis** - Perturbation analysis is frequently considered a theoretical tool with few applications. We think its application to large scale linear and nonlinear problems is vital for the implementation of reliable methods. In particular, the links with Statistics are deep and to find "a posteriori" methods for evaluating the confidence level

of large computational outputs has the greatest relevance in these applications. The rank-revealing method for least squares is a typical example of a difficult perturbation problem connected with statistical interpretations of the output.

4. **Statistical Applications** - We will focus on statistical signal processing, statistical communication, econometrics, quantitative finance, data mining, chemometric, and biomedical applications. In particular, the study of reliable bioinformatics numerical methods bridges the fields of numerical analysis, statistics, and biology. The use of structural properties of the matrices involved in the models and the use of total least-squares techniques can largely benefit the applications.

B1.3 Scientific originality

The scientific originality of the project is in the cross fertilization among several fields of research. Under the large scale scientific computing title, we often find problems that are solved with mathematical techniques that are not at the cutting edge. The time needed for the implementation of new successful ideas in industrial software is too long even taking into account the necessity of a complete validation of the new release.

We believe that a possible therapy for this malady is the training of a new generation of young applied mathematicians with a strong field of specialization, combined with an outstanding knowledge in several other fields of applied and computational mathematics and statistics. This can be achieved using our network of universities, research laboratories, and industrial research and development centres where the young researcher will be involved with the cutting edge research performed by one or more of us.

The second point of originality of the proposal is the relevance of statistics in several of the research lines. In particular, the numerical linear algebra teams have a long and productive record of collaboration with the teams using statistics tools through the experience of the ERCIM working group “Matrix Computation and Statistics”.

Computational Statistics has been of great relevance in the traditional fields of Economics and Social Sciences. Now it is becoming extremely relevant in several other sectors such as data mining, assimilation of data in the simulation of complex physical phenomena governed by partial differential equations, and biomedical applications. In particular, we hope to exploit new optimization techniques that allow us to solve problems with extremely large number of degrees of freedom ($> 10^7$).

We expect that several application areas will benefit from the results and the activities of the Network: We mention, for example, simulation of electromagnetic phenomena, electrical circuit theory, computational chemistry, computational biology, computational materials, CFD and structural engineering, mathematics for financial derivatives, finite-element modelling for medical simulation, environmental modelling, image and signal processing, econometrics, data filtering, information retrieval, statistical data mining, and data compression and representation.

B1.4. Research method

The main project objective is to integrate several new algorithms and numerical techniques in Scientific Computing and Statistics, in order to characterize and increase the accuracy of the models and to extend their field of applicability. We intend to achieve the target of integrating the competences of each team by using young scientists and by organizing meetings and schools, where each team can present in simple terms their problems or their algorithms. Presently, the two ERCIM working groups are already organizing similar activities.

Nevertheless, we feel the need for a more sustainable and institutional effort. The successes of integrated initiatives and the long standing record of cooperation between several of the teams, stimulates our proposal.
Moreover, we think that the area of Numerical Linear Algebra represents the natural "glue" that will maintain the cohesion between the teams. Its fundamental value is in its immediate applicability to several problems and in its closeness to the software. Therefore, we plan to use the expertise in Numerical Linear Algebra resident within the majority of the teams to ensure a thread-safe approach to the implementation of the research topics described in Section B1.2 of this proposal.

B1.5. Work plan

The four objectives described in Section B1.2 are subdivided into several tasks. We describe the contents of each task and, in the following Table-B1.5.1, we relate the teams to the tasks.

1.**Saddle point problems**:

- **Task-1.1.Direct methods**: comparison between the existing direct solvers and reordering techniques for fill-in control, parallel computing and grid computing. On the basis of this evaluation, improvement of existing, and development of new techniques.
- **Task-1.2.Iterative solvers**: Evaluation and improvement of the existing saddle point preconditioning techniques in combination with the Krylov and Chebyshev methods. Study and evaluation of the combination of saddle point preconditioners with spectral preconditioning (deflation of the smallest eigenvalues in absolute value). Study and evaluation of hierarchical solvers such as multigrid and Domain Decomposition.
- **Task-1.3.Mixed approach**: the study of mixed direct and iterative approaches and their comparison on very large problems with direct and iterative solvers, Null and Range Space algorithms.
- **Task-1.4.Applications**: application and comparison of these methods, taking advantage of the structural properties of the discrete operators to the solution of mixed finite-element approximations. Applications could include Darcy's laws, Biharmonic problems, Computational Fluid Dynamics, and Navier Stokes equations. Application of interior point algorithms for large scale problems in the numerical solution of PDE and in linear and nonlinear model estimation.

2.Computational statistics

- **Task-2.1.Least-Squares problem**: collection of large rectangular matrices and of nonlinear problems to be used as a benchmark problems, use of sparse QR algorithms to build preconditioners for the least-squares problems, and for the normal equations.
- **Task-2.2.Eigenvalues and singular value decomposition (SVD)**: application and evaluation of Lanczos-based and other iterative techniques for computing singular values of matrices arising in large-scale statistical applications.
- **Task-2.3.Total Least Squares**: development and evaluation of fast solvers for large-scale total least squares and structured total least squares problems arising in errors-in-variables modelling, including regularization and exploitation of the matrix structure. Study of applications in biomedical signal processing, errors-in-variables system identification and model reduction.
- **Task-2.4.Monte Carlo method and Markov chains:** comparison of the existing

quadrature techniques and study of fast eigensolvers for Markov chains.

3.Perturbation Analysis

Task-3.1.Theory and links with Statistics: study of the state-of-the-art techniques for error analysis and error propagation in numerical linear algebra and their application in error-in-variables modelling.

Task-3.2.Stopping criteria: identification of stopping criteria suitable for iterative methods applied to PDE and Least Squares. Study of these stopping criteria with respect to the a posteriori error estimation and the error control in relation to the underlying PDE.

Task-3.3.Nonlinear systems: study of the stability problem for the solution of polynomial equations and in nonlinear optimization. Implementations of the threshold accepting heuristic (TA) and memetic algorithms to the problem of model selection in cointegrated systems (VECM) and nonlinear settings (MS-VAR, multivariate SETAR).

Task-3.4.Rank-revealing problems: comparison of existing techniques for large scale least-squares problems and for the computation of singular value decompositions and pseudo-inverses.

4.Statistical Applications

Task-4.1.Statistical signal processing: Singular Value Decomposition (SVD) problems arise in several important and modern applications in signal processing and communications. Adaptive Antennas, Blind Channel Estimation in Code Division Multiple Access (CDMA), or in Orthogonal Frequency Division Multiplexing (OFDM), or finally in Multi-Carrier CDMA communication systems constitute some characteristic examples. The goal is to combine *iterative* SVD numerical methods with *adaptive signal processing algorithms*. Some first efforts (transformation of the Power Iteration to an adaptive algorithmic form) where very promising and yielded excellent results for the CDMA and OFDM channel estimation problem.

Task-4.2.Econometrics: investigation and development of efficient estimation procedures for large scale linear econometric models interfacing econometrics, computational statistics and numerical methods.

Task-4.3.Data mining: analysis of decomposition and compression of multi-mode arrays. Development of efficient algorithms for computing the HOSVD (Tuckermodel) and Parafac model. Improvement of algorithms for maximum likelihood estimation and inclusion of preprocessing of the data to deal with linear dependencies, for which the likelihood criterion must be modified to be applicable. Development of efficient algorithms for analysing data sets with missing values.

Task-4.4.Chemometric and biomedical applications: development of a common theoretical framework for Partial Least Squares (PLS) and the Lanczos method and of new and more efficient algorithms for PLS-related methods (OSC, DOSC, O-PLS etc.), based on constrained least-squares problems and Krylov methods.

5.Dissemination

Task-5.1.Internal Dissemination, providing collaborative tools, ensuring a coherent informatrion flow within the network and supporting the organisation of summer schools, workshop and conferences.

Task-5.2.External dissemination, through dedicated support ranking from NUMAS

web site, to news letters, ERCIM news and publications,. The objective is not only to advertise the network's activities but also to attract new candidates while promoting NUMAS achievements on a global scale.

6.Management

Task-6.1.Administrative coordination, to ensure the completion of the workplan, the production of reports and deliveralbles, to handle the adminsitrative dimension of the training programme (student contracts), to act an an interface with the Euroepan Commission and manage arising issues.

Task-6.2.Financial coordination, to ensure funding redistribution among the network teams, perform the managment of financial resources for and towards the students on fellowship.

For each scientific task, the major deliverable will be trained students, technical reports and scientific publications. We assume that some of the results will be incorporated before the end of the project in the numerical software libraries. This will be consistent with the tradition of several teams in building and maintaining software libraries. The general activity reports and annual reports will be delivered through task 6, to deliver a full vision of the network's activities.

Research and Training Activities

		Task																			
		1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	3.4	4.1	4.2	4.3	4.4	5.1	5.2	6.1	6.2
	1																	x	x	x	x
	2	x	x	x	x	x				x	x	x	x								
	3						x		x					x							
	4						x	x	x				x				x				
	5			x	x	x						x									
	6		x	x	x	x		x		x	x	x									
	7					x	x										x				
T	8		x	x	x	x	x	x	x	x			x	x							
e	9	x	x	x	x	x	x			x	x	x									
a	10	x	x		x	x															
m	11								x			x			x						
	12		x		x						x	x									
	13		x		x		x	x		x						x					
	14		x	x	x		x				x						x				
	15					x	x	x	x								x				
	16		x				x														
	17		x		x																
	18	x		x																	
	19						x	x	x					x							
	20	x	x			x	x	x	x							x	x				
	21		x		x		x														
	22	x	x	x	x	x															
	23					x	x	x		x					x		x				
	24	x			x											x					
	25				x	x	x			x	x	x	x								
	26		x		x		x				x	x									
	27	x	x		x		x			x	x				x		x				

Table B1.5.1

1 ERCIM**, 2** CCLRC-RAL, **3** Univ. of Salzburg, **4** KU Leuven,
5 Univ. Namur, **6** ICS-AS CR, **7** Royal Veterinary and Agricultural Univ., **8** INRIA/IRISA,
9 CERFACS, **10** INPT/IRIT, **11** Univ. of Erfurt, **12** Univ. of Dortmund, **13** Univ. of Patras,
14 IMATI-CNR, **15** IAC-CNR, **16** Univ. "La Sapienza" Roma, **17** Centre Henri Tudor,
18 Univ. of Bergen, **19** SAS (Slovakia), **20** Linköping Univ., **21** ETH Zurich,
22 Univ. Basel, **23** Univ. Cyprus, **24** Univ.Cardiff, **25** Univ. of Manchester,
26 Oxford Univ., **27** Univ. of Strathclyde

In Table-B1.5.2, we give the chart of the work plan. In the work plan, we also highlight the summer schools and the workshops and we indicate in which tasks each team will be involved.

		months															
		3	6	9	12	15	18	21	24	27	30	33	36	39	42	45	48
Tasks	1,1		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	1,2		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	1,3				x	x	x	x	x	x	x	x	x	x	x	x	x
	1,4				x	x	x	x	x	x	x	x	x	x	x	x	x
	2,1				x	x	x	x	x	x	x	x	x	x	x	x	x
	2,2		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	2,3		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	2,4				x	x	x	x	x	x	x	x	x	x	x	x	x
	3,1		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	3,2		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	3,3				x	x	x	x	x	x	x	x	x	x	x	x	x
	3,4				x	x	x	x	x	x	x	x	x	x	x	x	x
	4,1				x	x	x	x	x	x	x	x	x	x	x	x	x
	4,2				x	x	x	x	x	x	x	x	x	x	x	x	x
	4,3				x	x	x	x	x	x	x	x	x	x	x	x	x
	4,4				x	x	x	x	x	x	x	x	x	x	x	x	x
	5,1		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	5,2		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	6,1	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	6,2	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x

= Joint Workshops =Joint Summer Schools

Table B1.5.2

B2 Training and transfer of knowledge activities

B2.1 Content and quality of the training and transfer of knowledge programme

Our ambition is to create a new fellowship model in which all the actors of the advanced technological world can participate at some stage. Based on the experience developed in the context of ERCIM, we propose a fellowship programme where a young mathematician will spend part of his/her biannual fellowship in at least 2 academic institutions and, if his/her research studies are of immediate interest to an industrial associate partner, another part in an R&D centre. We propose the possibility of a renewal after the Steering Committee evaluates and recommends the value of the specific activities.

It is widely acknowledged today that young scientists represent one of the most rapid and cost effective means of dissemination and diffusion of new knowledge, methodologies and concepts to the industrial world. The Network will create an environment that will facilitate this process. It will also provide the framework for early interaction between young PhDs, postdoctoral researchers and industry. This interaction will enlighten researchers with the workings of industry, and will put industry in contact with potential new staff recruits specializing in areas that are of its specific interest. Furthermore, the involvement of industrial lecturers in the training and teaching programme will help academic researchers to select the key and difficult industrial problems needing new techniques.

The project involves 27 institutions, each one with an established record in research and in education. Among them we have nine research centres and laboratories with a vast range of expertises and competences in Numerical Linear Algebra (CCLRAC-RAL, Academy of Sciences of the Czech Republic, CERFACS, INRIA), in numerical solution of Partial Differential Equations (IMATI-CNR, H. Tudor RC), Optimization (CCLRAC-RAL, Academy of Sciences of the Czech Republic, INRIA), and in Computational Statistics and Statistical Applications (IAC-CNR, INRIA, RVA). Among the Academic Institutions and Universities we count some of the leading centres for research and education in Europe.

The fields of expertise of the University participants cover all the sectors indicated in Section B1.2. Moreover, all the Universities involved have both the administrative and the training skills required by the project.

Industry will be involved in the establishing of the lines of research and in the preparation of the calls for application. The allocation of some of the experienced researchers to industry will be decided in a later phase of the project when their training will reach a sound level.

The subdivision of the fellowships among the partners is based on the level of personal involvement declared by each of them. We divide the project into two phases:

1. The first year we will recruit 6 experienced researchers that will guarantee a sound start-up of the activities. The subdivision among the partners will reflect the resulting level of qualification of the researchers that the market will offer.
2. The recruitment of 21 early-stage researchers will start after the first year of the project. This delay will allow the academic institutions responsible for their PhD to fulfil the formalities required by the local University and by the national state legislation. The network Steering Committee will take charge of the scientific coordination between the hosting institutions and the original one.

The training of the early-stage and experienced researchers will be based both on individual transfer of knowledge and on the participation in summer schools where all the partners in turn will contribute with their personal involvement.

During the 4 years of the project, we plan 2 summer schools that will cover, during a three to four weeks period, the research topics described in Section B1.2 and other topics that might

arise in the future. Each team will have the opportunity to lecture on their research expertise.
The first summer school will serve as a bridge between the expertises on saddle-point computation in optimization, perturbation analysis, and numerical solution partial differential equations.
The second summer school will be organized around the use of advanced numerical techniques in statistical applications and optimization.
We will require the speakers and all the team members to produce lecture notes that will be used during the summer schools and that can become references in the scientific literature. These lecture notes will be made available on the Internet.
Furthermore, we will organise workshops and integrated teaching programmes involving industrial and national laboratory lecturers. We will take full advantage of electronic communication creating web pages where the scientific activities are presented, databases of test problems, and a newsletter. The Network will also provide the organizational support for the movement of the participating researchers across the institutions. Moreover, we will encourage all the early-stage and experienced researchers to present the results of their activities during the workshops organised during the project and we will support their participation in international conferences in their specific sector.
We anticipate that the use of the less traditional forms of communication (such as articles for non-specialists, web pages), as well as other types of activities, will enhance the appreciation of numerical mathematics and statistics in general, and will render the role and the contribution of the proposed Network in science and technology transparent for the general public.
The ratio between individual and network-wide training is a delicate issue that involves careful identification of the individual psycological and scientific needs of the early-stage researchers. The English language will be the official language of the network and we must assure that the early-stage researchers be fluent in it, taking into account that they are supposed to visit the other teams involved in their training. Thus, the balance between the individual training given by the institution legally responsible for the PhD and the period of individual training abroad must be decided by the tutors responsible for the early-stage researcher. The Research and Training Coordination Board (RTCB, see Section B4) will arrange that all the early-stages and the experienced researchers have the possibility of participating at the common summer schools and to the common workshops.
Finally, the presence of national laboratories equipped with large computing facilities such as the HPCx at CCLRC will give the possibility to all the participants and specially to the early-stage and experienced researchers to be trained on the use of state-of-the-art parallel techniques and advanced numerical software.

B2.2 Impact of the training and/or transfer of knowledge programme

The use of numerical mathematics and statistics plays a vital part in the USA technological leadership. We cite as an example Google that uses some of the basic numerical analysis tools to solve enormous statistical problems (Markov chain) related to data-mining. The American NSF increased the budget for 2003 by 20% with respect to the previous year and a considerable part of the budget is targeted to education[1]. In Europe the applied mathematics competences are scattered and fragmented and they lack the recognition awarded in the US. By gathering together the disseminated expertise in Europe into a European training

[1] see http://www.siam.org/siamnews/03-02/budg03.htm

environment, we intend to ensure a future and lasting flow of young experts in the area. Because some regions actually suffer a lack of means and expertise, it is an important aspect of the proposed network to develop doctoral level courses not typically available in European universities. ERCIM, among other organizations, takes charge of sponsoring the mathematical and statistical activities within the national laboratories. The ambition of our network is to start the seminal work of gathering the national laboratories with European universities in a common educational project involving top quality research.

Furthermore, we want also to promote an interdisciplinary action within the field of computational mathematics and statistics. Besides a strong specialist training, we will stimulate all the actors involved to have a sounder knowledge of all the research developed in the network. This will hopefully prepare a new generation of researchers inclined to exercise more lateral thinking in their work. This initiative relying on pan-European assets will pay back the scientific community supporting it by providing a younger generation of qualified researchers to uphold Europe' expertise in computational mathematics and statistics. Beyond this direct result, NUMAS will also support the European scientific community through a number of underlying side effects.

First, the added value of such a European training network is a real opportunity for the new and future members states. The European Research Area will directly benefit from this initiative as it will help new member States to adjust their expertise. Indeed, new member States have often a very strong mathematical tradition with excellent educational programmes with a still high participation rate, but it appears that they often lack good programs for training in applied mathematics and applied research This situation not only explains why these countries will profit from the network activities, but also highlights the fact that NUMAS will also benefit from the local expertise these countries have preserved and developed as a tradition.

Another side effect of NUMAS will be to improve the strength of research and support the existence of a European-wide network. This will prove essential in our effort to keep the best researchers in Europe. A major part of the world leading researchers in the area are European, yet too often they work in the US. This project will contribute to the general effort to reduce or reverse this traditional brain–drain. It is the network's intention to capitalise on the existing the European excellence in the field to further develop the expertise of this research community.

We will give the early-stage and experienced researchers the opportunity of an early involvement in an international multidisciplinary environment and of building a strong personal relationship with the European and international actors in the cutting edge of mathematical and statistical research. We want to promote the image of mathematics and statistics beyond the borders of our project making available the material used for the training of our young researchers to a larger sector of the public by the creation of specialized web pages where the topics of our researches are presented in simple but precise terms to all the non-specialist scientific community and to the interested public.

As mentioned previously, part of the impact of this training programme is to ensure a future and permanent flow of young experts in the field. This permanence is also part of the rationale behind the proposed mix of early-stage and experienced researchers. By bringing together post-docs and pre-docs, we hope to enrich the community with shared expertise and create links among distinct generations of researchers, as a first spark towards future collaboration. The underlying idea is to get experienced researchers to assist early-stage researchers in the development of their future careers. This will act as an early transfer of knowledge in which the network believes researchers will rely on to pass knowledge and expertise.

The subdivision between early-stage and experienced researchers and their distribution among the teams has been motivated by additional technical and institutional reasons. Some national laboratories do not have the juridical authority to concede academic titles. Nevertheless, they

are the repositories of extremely valuable specialist competences and of cutting edge computing equipment. These two qualities add values to the network giving the opportunity to the young researchers to become familiar with world class supercomputers and to be involved in the theoretical and practical design of numerical advanced software.
We anticipate that the impact of 27 new researchers in the fields of computational mathematics and statistics will improve the human resources of the teams involved. The successeful achievement of the research objectives and the transfer of the relative know-how and of the skill in using the related numerical software will enhance further the reputation of teams involved and will promote and assist the future career of the early-stage and experienced researchers at the international level. In this respect, we plan to invite among the speakers of our workshops and the teachers of our summer schools selected international non-European specialists. This will give the additional opportunity to build additional personal relationships between our young researcheres and the international scientific community.
Finally, ERCIM will take responsability of advertising the results and the transfer of the know-how at the European and the national level through its institutional channels.
With its European dimension and joint programme for post-docs and pre-docs, this multidisciplinary training network will promote excellence across the boundaries, between disciplines, educational systems and age generations.

B2.3 Planned recruitment of early-stage and experienced researchers

From experience of earlier participation in European networks, we believe that there is a need for an important recruitment effort in the beginning of the project. A slow start in the recruitment can otherwise become a major difficulty. Experience shows that recruiting young researchers from western European countries is not an easy task. We are convinced however that extending our recruiting areas to the new members states will guarantee that it is possible to recruit excellent candidates. We will start recruiting as soon as possible by advertising vacancies on the web (Cordis, NUMAS webpage and our institutions webpages), in journals and electronic newsletters. NUMAS will also contact colleagues throughout Europe, including the new member states, and this is expected to lead to the main source of candidates.

Owing to the realistic difficulty of recruiting of early-stage researchers, we plan to proceed during the first year with the recruitment of 6 experienced researchers that will help the start-up process and will sustain the cross-fertilisation effort during the first 2 years. We will use all the electronic (na-net the numerical analysis network and NEOS the optimisation network) and classic channels of information for advertising the positions. The recruitment will also be sought via the extensive European Grid network. Many Grid applications involve numerical computing, and this will provide a useful recruitment and dissemination channel for a network of this kind.
The experience of ERCIM in running its fellowship programme will be crucial in this phase. During the first year, the university teams will proceed in the selection of suitable candidates with the necessary intellectual qualities and suitable background. The ERCIM consortium advertises postdoctoral fellowships throughout Europe twice a year. This campaign results in roughly 150 candidates in all areas of applied mathematics and computer science, including discrete mathematics, systems and control and computer science and this constitutes an excellent source of candidates for experienced researchers positions.

Particular care will be paid to ensure that all candidates get equal opportunities. Moreover, all partners are well aware of the necessity to promote the gender issues during the recruitment procedure. It will be clearly indicated in the advertisement that the consortium decides to

ensure the participation of at least one third of each gender in the project, and evaluators will be briefed before any evaluation of the candidates.

We believe that the training programme will initiate a permanent flow of young European experts in the area of Computational Mathematics. This objective will be achieved by making the research area more visible in Europe, by the organisation of workshops and summer schools that will be open to the entire European research community, by the dissemination of our lecture notes to all network institutions, and by the close interactions between earlystage and experienced researchers within the network. Thus, the total person-months request for experienced researchers is 144 months (6×24 months) and for early-stages researchers is 756 months (21×36 months).

Early-stage and experienced researchers to be financed by the contract				Other professional research effort on the network project	
Network team	Early-stage researchers to be financed by the contract (person/month) (a)	Experienced researchers to be financed by the contract (person/month) (b)	Total (a+b)	Researchers likely to contribute (number of individuals)	Researchers likely to contribute (person/months)
1	0	0	0	2	40
2	0	24	24	4	40
3	36	0	36	2	16
4	72	0	72	11	80
5	36	0	36	2	20
6	0	24	24	11	45
7	36	0	36	2	20
8	0	24	24	4	40
9	0	24	24	11	75
10	36	0	36	4	30
11	36	0	36	3	20
12	36	0	36	6	30
13	36	0	36	2	16
14	0	24	24	6	50
15	0	24	24	7	40
16	36	0	36	2	16
17	36	0	36	1	14
18	36	0	36	2	16
19	36	0	36	3	16
20	36	0	36	8	10
21	36	0	36	2	20
22	36	0	36	1	48
23	36	0	36	1	16
24	36	0	36	3	20
25	36	0	36	4	20
26	36	0	36	8	35
27	36	0	36	4	20
Totals	900	900	900	900	900

B3 Quality/Capacity of the network partnership

B3.1. Collective expertise

The following countries and organisations will participate in the Network as the core group

1.Austria: Institute for Scientific Computing, University of Salzburg (ISCS) [3]
2.Belgium: Department of Electrical Engineering, (KUL-SISTA) and Department of Computer Science (CS-NA/AM) Katholieke Universiteit Leuven [4], University of Namur (UniNamur) [5]
3.Czech Republic: Institute of Computer Science, Academy of Sciences of the Czech Republic (ICS-AS CR) [6]
4.Denmark: The Royal Veterinary and Agricultural University (RVA) [7],
5.France: INRIA/IRISA [8], CERFACS [9], INP Toulouse/IRIT (INPT/IRIT) [10]
6.Germany: University of Erfurt [11], Unversity of Dortmund [12]
7.Greece: University of Patras (UPG) [13]
8.Italy: IMATI [14], IAC [15] (CNR), Universitá “La Sapienza” Roma [16]
9.Luxembourg: Henri Tudor research center [17]
10.Norway: University of Bergen [18]
11.Slovakia: Academy of Sciences of Slovakia (SAS) [19]
12.Sweden: Linköping University (ULS) [20]
13.Switzerland: ETH Zurich [21], University of Basel [22]
14.U.K: CCLRC-RAL [2], University of Cardiff (UCW) [24], University of Manchester [25] (UMUK), Oxford University [26] (OUUK), University of Strathclyde [27] (USTRATH).
15. University of Cyprus [23] (in collaboration with Université de Neuchatel)

In Table B1.5.1, we list the organisations that have agreed with this proposal with their field of interest and expertise. The number of researchers involved is **116**. Among them we count some of the best worldwide specialists in their sector. The multi-disciplinary skills and critical mass make the proposed Network a world leader in the fields of numerical mathematics and statistics.

B3.1 Teams contributions

Team 1 contribution ERCIM, European Research Consortium for Informatics and Mathematics

The European Consortium for Informatics and Mathematics (ERCIM) is an EEIG. Through this unique structure, seventeen different national research organisations with strong activity in IT research and development, in as many European countries are tooled to participate in joint projects, keeping the management simple and effective.
ERCIM members are all research organisations, or national consortium of research organisations and universities, with strong activity in I.T. research. Members are: Austrian Association for Research in IT (AARIT), Council for the Central Laboratory of the Research Councils (CCLRC), Consiglio Nazionale delle Ricerche (CNR), Czech Research Consortium for Informatics and Mathematics (CRCIM), Centrum voor Wiskunde en Informatica (CWI), Fonds National de la Recherche (FNR), Foundation for Research and Technology Hellas (FORTH), Fraunhofer ICT Group (FhG), Institut National de Recherche en Informatique et en automatique (INRIA), Norwegian University of Science and Technology (NTNU), Spanish Research Consortium for Informatics and Mathematics (SpaRCIM), Swedish Institute of Computer Science (SICS), Swiss Association for Research in Information Technology (SARIT), Slovak Research Consortium for Informatics and Mathematics (SRCIM), Magyar Tudományos Akadémia Számítástechnikai és Automatizálási Kutató Intézet (MTA SZTAKI), Trinity College Dublin (TCD), and Technical Research Centre of Finland (VTT). In addition, ERCIM became the European host for the W3C on first January 2003.

ERCIM has its central office located in France and acts as a frontend to access the scientific expertise of its members (e.g. ERCIM has acted as an evaluation agency for the "InfoDev" World Bank programme). The Office has set up strong internal and external channels for solicitation and dissemination. ERCIM has considerable experience in managing Eufunded projects (more than 30). ERCIM has its own **International Fellowship Programme** and Internal Mobility scheme. It also organises prospective workshops (like the EU/NSF ones), seminars and conferences. The ERCIM Office has also a very valuable competence in results dissemination, as part of its assets rest with customised web design, setup and assistance, and the edition of the ERCIM News magazine (over 11000 copies distributed worldwide).

This, combined with the seventeen research organisations disseminated across Europe makes ERCIM a key player in European IT research and development, and a reliable foothold for international cooperation. The contribution of ERCIM in NUMAS will capitalise essentially on ERCIM proven expertise in project **management and in administrating student training programmes**. Indeed, ERCIM has been carrying out its own fellowship programme since 1989. The ERCIM fellowship programme has given the opportunity to many PhD students to receive not only funding but also the opportunity to work with leading research institute in Europe, often on joint projects brining the student to be detached to two distinct institutes throughout his/her thesis. ERCIM will therefore bring its expertise in the domain to alleviate the administrative hassle and time consuming contract management, in order to allow the scientific partners to focus on their training and research activities.

Key persons:
Bruno Le Dantec was born in 1963 in Rennes, France. He has a degree in law and finance. Since 1992 he is deputy manager of the EEIGERCIM. His main activities consist in providing assistance and expertise to ERCIMpartners submitting proposals to the European

Commission, managing European contracts (IST, Esprit, Telematics, IncoDC...), organising workshops in the IT domain and administrating the EEIGERCIM.
Percentage of full time employment: 10

Peter Kunz was born in 1965 in Hornberg/Schw., Germany. He obtained a master of science degree (Dipl.Ing. FH) at FHD Stuttgart in Germany. His skills involve design and production in the field of communication technologies, printed and electronic media. He is currently in charge of the editorial board of both printed and electronic publications of ERCIM.
Percentage of full time employment: 10

Emma Lière was born in 1972 in Poitiers, France. She obtained a Bachelor's degree in French law and a Masters degree in International Law with a specialisation in European Law. She also began a PhD regarding the intellectual property. She is currently in charge of the ERCIM Fellowship Programme. Percentage of full time employment: 10

Team 2 contribution CCLRC-RAL Numerical Analysis group

Members of the Numerical Analysis Group at RAL (formerly at Harwell) have played a leading role in promoting, developing, and encouraging the research and development of algorithms and software for large-scale linear and nonlinear systems. The orientation of the work is to develop underlying theory and algorithms that can be realized as computer codes. The Group continues to develop and support HSL (formerly the Harwell Subroutine Library) and its sparse codes are used as a benchmark by the international community.
Our major achievements in linear algebra include the development of frontal methods, the introduction and development of multifrontal methods, and the design of robust eigensystem algorithms. In association with this work, we are developing powerful ordering techniques and auxiliary routines for scaling and manipulating sparse matrices. Moreover, we are developing stopping criteria for Krylov iterative method based on backward error analysis and perturbation theory, that are particularly suitable when the underlying problem is a finite-element approximation of a partial differential equation. We are currently investigating partitioning schemes and their use in solving sparse unsymmetric equations, considering in particular stability issues and the exploitation of parallelism.
The Group' s research in optimization has resulted in stateof the art codes for large-scale unconstrained, bound constrained and nonlinearly constrained minimization, as well as for quadratic programming. As nonlinear structure is often complicated to describe, sophisticated user interfaces have been developed. An important aspect has been the identification of key linear algebraic requirements within optimization algorithms, and the subsequent development of suitable solvers. Other software projects for which the Group is internationally renowned are the nonlinear optimization library GALAHAD, which includes the well-known LANCELOT package, and the optimization testing environment CUTEr. The test environment CUTEr has become the standard tool for testing nonlinear optimization software. Both packages are freely available to researchers, and have been installed at over one thousand sites world wide.

Key members of the team

Prof. Iain S. Duff (team leader) (5%)
Prof. Nicholas I. M. Gould (10%)
Dr. Jennifer Scott (10%)
Dr. Mario Arioli (30%)

Two Most Significant Recent Publications

I. S. Duff and J. A. Scott, "A parallel direct solver for large sparse highly unsymmetric linear systems", RAL-TR-2002-033, 2002.

A. R. Conn, N. I. M. Gould and Ph. L. Toint, *Trust-region methods*, SIAM/MPS Series on Optimization, SIAM, Philadelphia (2000), ISBN 0-89871-460-5.

Team 3 contribution Institute for Scientific Computing, University of Salzburg

The first topic covered by the Salzburg team concerns data retrieval and modification by methods of linear algebra. In order to manage rapidly increasing production of data from various fields, techniques which help to retrieve a desired information from such overwhelming data sets have to be developed. Our goal is a development of parallel algorithmic solutions to the intelligent information retrieval in large text collections encoded by the Latent Semantic indexing (LSI) technique. The retrieval problem is transferred to vector spaces where methods of parallel linear algebra are applicable. Among them, the Singular Value Decomposition (SVD) plays a crucial role. The project will pay a special attention to the parallelization of this method and to the investigation of various aspects of its suitability to deliver acceptable retrieval outputs. For representative real data sets, these new algorithms will be compared to routines from standard parallel linear algebra libraries. The final retrieval system will be implemented under MPI on a high-performance computer cluster installed at the Institute of Scientific Computing, University Salzburg and will run on matrices produced by retrieving a collection of WWW-pages. This theme is complementary to the work of the partner institutes from the Slovak Academy of Sciences and Czech academy of Sciences. They will develop new fast SVD algorithms which will be directly used for our application.

The second theme from our team discusses efficient video encoding techniques. The ongoing standardization process in the context of MPEG-4 has led to the development of highly efficient (in terms of compression performance) but on the other hand extremely demanding (in terms of computational complexity) algorithms. In particular, we will focus onto the recently finalized H.264/AVC video coding standard which increases the computational demand as compared to MEPG-4 part I by a factor of three. Here, especially the detailed analysis of multiframe prediction is a prerequisite for efficient distributed execution. As a second target algorithm we will treat motion compensated wavelet video coding systems which will also be included into MPEG-4 as scalable video coding system.
We will develop prototype implementations under MPI and OpenMP and will investigate possibilities for execution on Grid-based systems.
The key persons:
Prof. Marian Vajtersic is expert on algorithms of parallel linear algebra and on fast methods for scientific computing applications. He published more than 80 papers and is author of 4 book monographs and editor of 9 conference proceedings. He coordinated three EU projects (Copernicus and Esprit Programmes), a NATO funded project and a number of national projects. He is holder of the Humboldt Fellowship and of the Royal Norwegian Fellowship.
Prof. Andreas Uhl is expert in multimedia signal processing with focus on compression and encryption issues. He has also a strong background in parallel and distributed processing. Andreas Uhl published more than 120 papers and is editor of 7 conference proceedings and 2 journal special issues. He is project leader of several national FWF-funded projects in the area of wavelet based image processing.
Two publications related to the above themes:

Feil, M., Uhl, A.: Motion-compensated wavelet packet zerotree video coding on multicomputers. Journal of Systems Architecture, 2003, To appear.

Okša, G., Bečka, M., Vajteršic, M.: Parallel SVD computation in updating problems of latent semantic indexing. Proceedings ALGORITMY 2002, Technical University Press, Bratislava, 2002, 113-120.

Team 4 contribution Katholieke Universiteit Leuven (KUL-SISTA and CS-NA/AM)

The Katholieke Universiteit Leuven consists of the following two groups: KUL-SISTA and CS-NA/AM. The Group KUL-SISTA has a long term expertise in numerical algorithms development for numerical linear algebra, system identification and control theory, signal processing and non-linear systems. In these areas, the group has built up an international reputation in the last 10 years via the publication of 11 books, more than 280 papers in international journals and more than 520 conference contributions. The group also developed several software toolboxes, in particular: N4SID (subspace identification toolbox in Matlab and XMath), SEBANN (Simulation environment for Bayesian and artificial neural networks), LS-SVM (Matlab toolbox for Least-Squares Support Vector Machines), AKSES (Java based user interface for short echo-time Magnetic Resonance Spectroscopy data quantification), INCLUSive (toolbox for micro-array data processing).
Size of the team: 6 professors, 2 visiting professors, 12 postdoctoral researchers, 80 PhD students, 4 support staff members.
The group runs a year-round seminar series, organizes conferences, and runs a Graduate School for Systems and Control, which provides a structured framework of training activity for graduate research students, with special focus on the mathematical and algorithmic concepts.
Key scientific staff and Research Interests
The research interests of the group fall broadly into four areas: numerical linear algebra, system identification and control theory, signal processing and non-linear systems. The key scientific staff from the 2 former areas will be most actively involved in the project.
Professor Sabine Van Huffel is full professor. Her research interests are in numerical linear algebra, errors-in-variables regression, system identification, pattern recognition, (non)linear modelling, numerically reliable software for systems and control parameter estimation and signal processing. In these areas, she has authored one book, and more than 90 papers in International Journals and 120 conference contributions. In particular, she has been the central coordinator of the European thematic Numerics in Control network NICONET (1996-2002) and is chairperson of the numeric in control international society NICONET.
Professor Bart De Moor is full professor. His research interests are in numerical linear algebra and optimization, system theory and identification, quantum information theory, control theory, data-mining, information retrieval and bio-informatics, areas in which he has (co)authored several books and hundreds of research papers. His work has won him several scientific awards (Leybold-Heraeus Prize (1986), Leslie Fox Prize (1989), Guillemin-Cauer best paper Award of the IEEE Transaction on Circuits and Systems (1990), Laureate of the Belgian Royal Academy of Sciences (1992), bi-annual Siemens Award (1994), best paper award of Automatica (IFAC, 1996), IEEE Signal Processing Society Best Paper Award (1999). He is an associate editor of several scientific journals.
Dr Philippe Lemmerling is a postdoctoral researcher. His research interests are in structured matrix problems, errors-in-variables, with focus on numerical aspects and practical evaluation in biomedical signal processing.

Two Most Significant Recent Publications

P. LEMMERLING, L. VANHAMME, S. VAN HUFFEL AND B. DE MOOR, *IQML-like algorithms for solving structured total least squares problems: a unified view*. Signal Processing, Vol. 81, No. 9, 2001, pp. 1935-1945.

S. VAN HUFFEL AND P. LEMMERLING, editors, *Total least squares and errors-in-variables modeling: Analysis, Algorithms and Applications*, Kluwer Academic Publishers, Dordrecht, The Netherlands, 2002, 400 pp.

The Numerical Analysis and Applied Mathematics unit of the Department of Computer Science (CS-NA/AM) consists of 3 subgroups: NALAG, NINES and TWR. The Numerical Approximation and Linear Algebra Group (NALAG) aims at developing basic generic tools in numerical linear algebra (in particular structured problems) and in modelling and approximation (especially splines, wavelets and rational approximation) for the solution of engineering problems. This research includes the theoretical, the numerical and the implementation aspects of these problems.
The Numerical Integration, Nonlinear Equations & Software Group (NINES) has two main research areas: numerical integration, i.e., quadrature and cubature including quasi-Monte Carlo techniques, and, nonlinear equations, i.e. systems of polynomial or analytical equations.
The research of the Scientific Computing Research Group (TWR) focuses on the development of numerical methods, algorithms and software for solving large scale simulation problems in science and engineering. Much attention is paid to computational efficiency, robustness and implementation on high performance (parallel) computers.

Team:

The division consists of 9 professors, 9 postdocs (6 full-time and 3 part-time) and around 30 PhD students.

Activities:

Over the past 5 years, 11 students obtained the PhD degree. The group produced around 140 papers in scientific journals, 60 papers in proceedings of international conferences, 100 talks during international conferences which were only published as an abstract, 3 books as author and 2 books as editor, several software packages (WAILI: wavelets with integer lifting, FRFT: Fractional Fourier Transform, SSPack: Semiseparable matrices, Cubpack++: automatic integration of functions over two-dimensional regions.

Training for early-stage researchers:

Almost every week there is an internal meeting within each research group. We have designed an internal website allowing us to distribute in an easy way informal reports of these meetings and other relevant information, like slides of the talks. In several of these weekly meetings, the PhD-students are asked to explain the progress of their research or give a lecture on a more general topic.
Each member can obtain the LaTeX-files of articles, talks, posters of another member. This facilitates exchange of ideas and information not only concerning research but also connected to practical problems. A small database is kept with the information of the conferences relevant for our research. Another database contains information on the researchers working in the field of structured matrices and related topics. The team regularly organizes series of seminars at PhD level.

Key scientific staff who will be involved in the research:

- Marc Van Barel (coordinator): numerical linear algebra, 10%
- Adhemar Bultheel: numerical linear algebra, complex analysis, 5%
- Ronald Cools: multivariate numerical integration, quasi-Monte Carlo methods, systems of polynomial equations, 5%
- Ann Haegemans: numerical integration, 5%
- Dirk Roose: nonlinear dynamical systems and bifurcation analysis, algorithms and

software for scientific computing, 5%

- Stefan Vandewalle: numerical methods for ordinary and partial differential equations, iterative methods (multigrid, domain decomposition, waveform relaxation, Krylov methods), parallel and high performance computing, 5%

Two most significant recent publications:

M. Van Barel, G. Heinig, and P. Kravanja, A Stabilized Superfast Solver for Nonsymmetric Toeplitz systems, SIAM J. Matrix Anal. Appl. 23 (2), pp. 494-510, 2001.

K. Engelborghs, T. Luzyanina, en D. Roose, Numerical bifurcation analysis of delay differential equations using DDE-BIFTOOL, ACM Trans. Math. Softw. 28 (1), pp. 1-21, 2002.

Team 5 contribution Numerical Analysis Department of Mathematics at the University of Namur (FUNDP)

The Numerical Analysis Unit of the Department of Mathematics at the University of Namur (FUNDP) has been at the forefront of research in algorithmic nonlinear programming for more than 10 years. Its expertise covers methodological issues, such as the design of algorithms involving trust regions, interior-point techniques, sequential quadratic programming and, more recently, filter methods. Special emphasis has been put on solving large-scale nonlinear problems (which currently means designing methods for optimization in more than 100.000 variables), as well as on applying the resulting methods for solving real problems (weather prediction, biological modelling, progressive adaptive lens design or energy distribution, to mention a few). This methodological approach is completed by a clear interest and expertise in developing scientific software packages. In particular, the team was (with RAL) at the origin of well-known packages like LANCELOT (the first truly large-scale nonlinear optimization solver, 1994 Beale-Orchard-Hayes Prize), CUTE and CUTEr (today's standard environment for testing and comparing nonlinear equations and nonlinear optimization packages), and the new ongoing GALAHAD software library (containing various optimization solvers and tools with emphasis on large-scale calculations). The FUNDP's team expertise is very complementary to several other network teams. As numerical optimization experts, the team members are heavy users of both direct and iterative linear algebra techniques, which is amongst several other network participants' expertise (RAL, Utrecht, SARIT, INRIA, Czech Academy of Sciences). Moreover, optimization often occurs as an integral part of some modelling exercises using partial differential equations, a domain of expertise of other network members (CNR, RAL..) The FUNDP team has had over 10 Ph.D. students in recent years. Its members have actively participated in a number of international conferences, the latest one being as invited plenary speaker at the ICIAM 2003 in Sydney. The team's publication list is extensive (over 100 papers in refereed journals and several books including the reference book on trust-region methods (Conn, Gould, Toint, SIAM, 2000)). The team members have also enjoyed a number of collaborative visits in several foreign laboratories (CERFACS, IBM, Northwestern University, RAL, Universtity of Canterbury (NZ), ...) and industries (INDO (Barcelona), Tractebel, Meteo-France,...). The key scientific staff involved are Pr. Ph. Toint and Pr. A. Sartenaer, both of them sharing the above described expertise, and planning an involvement of approximately 1/5 full-time.

Global convergence of trust-region SQP-filter algorithms for nonlinear programming, R. Fletcher, N. I. M. Gould, S. Leyffer, Ph. L. Toint and A. Waechter, SIAM Journal on Optimization, 13(3), pp. 635-659, 2002.

Superlinear convergence of primal-dual interior-point algorithms for nonlinear programming, N. I. M. Gould, D. Orban, A. Sartenaer and Ph. L. Toint, SIAM Journal on Optimization, 11(4), pp.974-1002, 2001.

Team 6 contribution Academy of Sciences of the Czech Republic
The Department of Computational methods at the Institute of Computer Science (a member of CRCIM) consists of three groups working in different but closely related fields:

1. Numerical linear algebra and theory of matrices
2. Numerical methods of smooth and non smooth optimisation, nonlinear programming and solving nonlinear algebraic systems
3. Mathematical modelling of problems in elastoplasticity

Research effort in the first group has been recently focused on development, analysis, implementation and application of scalable algorithms for solving extremely large generally sparse linear algebraic systems including preconditioning and implementation on parallel computer systems (Tůma, Rozložník); theory of convergence and numerical behaviour of Krylov subspace methods (Strakoš, Rozložník, Tichý); mathematical foundations and numerical methods in error-in- variables modelling (Strakoš); mathematical properties of special matrices (Fiedler); theoretical and computational aspects of problems with interval data (Rohn).
In the second group the research work is recently oriented towards computational methods for solving non smooth large scale systems of nonlinear equations, which are applied to nonlinear complementarity problems and variational inequalities as well as efficient globally convergent variable metric methods for nonsmooth optimization and large scale nonlinear programming. Sequential quadratic programming and interior point methods for large scale nonlinear programming are also investigated and implemented and special preconditioners for indefinite KKT systems are investigated. As an accompanying activity, an extensive software system for universal functional optimization UFO is being developed. (Lukšan, Vlček)
Third group focuses on mathematical modelling of contact problems with friction in elasticity and thermo-elasticity Theoretical results are applied in several important areas in mechanics, geomechanics and technology. (Nedoma, Hlaváček) In addition to theoretical research our department is involved in important applications. The project on remediation of environmental problems due to the chemical mining of uranium in Straz pod Ralskem represents the typical example (Maryška, Hokr, and Rálek).

The members of the research team:

Zdeněk Strakoš, Miroslav Tůma, Miroslav Rozložník, Petr Tichý, Ladislav Lukšan, Jan Vlček, Jiří Maryška, Milan Hokr, Petr Rálek, Miroslav Fiedler, Jiří Rohn

The most significant recent publications:

J. Liesen, M. Rozložník and Z. Strakoš, Least Squares Residuals and Minimal Residual Methods, SIAM Journal on Scientific Computing, Vol. 23, No. 5, 2002, pp. 1503-1525.

C. C. Paige and Z. Strakoš, Bounds for the Least Squares Distance using Scalled Total Least Squares, Numerische Mathematik, Vol. 91, 2002, pp. 93-115.

Team 7 contribution The Royal Veterinary and Agricultural University (RVA)
Department of Dairy and Food Science **Food Technology Section – Chemometrics Division**

The relatively recent starting point of chemometrics can be found in the mathematical and statistical data handling in analytical chemistry. Modern multivariate instrumentation opened up the way to a multitude of high quality information sources, creating the demand for novel computational methods. In a dynamic development spiral the umbrella of chemometrics now covers such diverse fields as process, environmental and food-safety monitoring and control, bioinformatics and quantitative structure-activity relationships in pharmaceutical research.

Where the common denominator is the statistical and mathematical methodologies used, the application field expertise makes the differentiation. The chemometrics group at RVA plays a key role in food- and medicine-related education, research and development. All this is done in a close corporation with the Spectroscopy Group in the Food Technology Section. The group also plays a leading role in the development of multivariate multi-way data analysis. Where multivariate data will fit in a data table of samples by variables, novel hyphenated instruments in analytical chemistry are able to generate data in the form of cubes or hyper-cubes of samples by variables in different directions. Various methods for information-extraction from these complicated structures are developed, often in close collaboration with researchers from statistics, psychometrics and signal processing. In these new developments both the application and the algorithmic aspects - such as new methodology development, speed-up strategies of the notoriously complicated optimization problems, constrained model solutions and parameter uncertainty estimates by re-sampling strategies - are investigated.

Another very important aspect of our research is the translation of data-analytical methodologies into useful application for other university departments and industrial partners. This ranges from animal breading experiments, sensometric product evaluation, analytical instrument vendors, pharmaceutical product development and quality control, and many more. The challenge (and reward) in this matter is to explain complicated statistical and mathematical modeling methods to non-experts. This can often be realized by the use of graphical representations for both the methodologies and the analysis results before going into the numerical details involved. Via this route many academics and industrial researchers from Denmark and worldwide have been educated and trained by members of the Food Technology Section. This - over the last years - has resulted in Denmark being one of the top countries in both (academic) chemometric research and everyday industrial use.
In line with this thinking an extensive Internet structure is maintained by the group to communicate and freely share information, publications and computer algorithms with all those interested.
The most significant recent publications:
R. Bro and A. K. Smilde. Centering and scaling in component analysis. J.Chemom. 17 (1):16-33, 2003.
R. Bro, N. D. Sidiropoulos, and A. K. Smilde. Maximum likelihood fitting using simple least squares algorithms. J.Chemom. 16 (8-10):387-400, 2002.

Team 8 contribution INRIA/IRISA
The research team Aladin (“Advanced algorithms for scientific computing”) is located in Rennes being part of the research center IRISA. IRISA is devoted to on Computer Science research. It is managed by an agreement between the University of Rennes 1, INRIA and CNRS. The present proposal applied on behalf of INRIA.
INRIA is a national institute of research in Computer Science and Applied Mathematics composed of six research centers including the center of Rennes which is a part of IRISA. It gathers 400 researchers, 500 engineers and technicians, 750 post-docs and visitors, 700 doctoral candidates and 450 researchers from other organizations. The institute is the French member of the ERCIM consortium. (see http://www.inria.fr/index.en.html).
IRISA is a research laboratory with a staff of 468, including 254 full-time research scientists or teaching research scientists and 153 doctoral candidates. The home network involves 900 computers ranging from the Unix workstation to the Linux or Windows laptop. (see http://www.irisa.fr/accueil/index_uk.htm).
Among twenty research teams, Aladin is a group involving 10 researchers. The present proposal activity is run by four researchers (see below). Their research interest is focused on methods for linear algebra (iterative methods for linear systems, eigenvalue problems, SVD),

software for sparse matrices and parallel computating. Furthermore, their knowledge on numerical solvers is applied on environmental problems, specifically in hydrogeology. The group has a strong US connection with Yousef Saad (University of Minnesota) and A. Sameh (Purdue University) through an existing network supported by INRIA and NSF, in which some of the activities of this proposal are strongly related (QR factorisation for sparse matrices). P. Amestoy (Cerfacs) and E. Gallopoulos (U. Patras) who are involved in the present network are also partners in the NSF/INRIA agreement. The group is also very much involved in cooperation with several African and Middle East countries. Therefore the geographic area of the origin of the applicant researchers will be more efficiently extended to these countries.
The members of the research team are :

Jocelyne Erhel, (INRIA Director of Research) is involved for 20 % of her time in this proposal. She is the group leader of Aladin. She advised 8 PhD researchers. Her research interests are in linear algebra, grid computing, numerical simulation in hydrogeology. She will be the INRIA representative in the NUMAS programme.
Bernard Philippe, (INRIA Director of Research) is involved for 25 % of his time in this proposal. He was the advisor for 17 PhD researchers. He was the coordinator of two European HCM actions (COPERNICUS programme : PORTRAIT CP94-682 and STABLE CP96-237). His scientific interests are on methods for solving eigenvalue problems and on parallel computing. With E. Kontoghiorghes, he coordinates the ERCIM working group Matrix Computations and Statistics which is one of the two groups which this proposal is built up on. In the proposal, he coordinates the activity on the QR factorization for sparse matrices and he will contribute in the activity on eigenvalue computations.
Frederic Guyomar'ch, (U. Rennes 1, Associate professor) is involved for 20 % of his time. He works on eigenvalue solvers.
Edouard Canot, (CNRS, Researcher) is involved for 20 % of his time. He works on CFD and Grid computing.

The two most relevant and significant publications :

[2002a] D. Mezher and B. Philippe. Parallel Computation of Pseudospectra of large matrices. Parallel Computing, 28 , no.2, pp. 199-221, 2002.
[2002a] H. Hoteit, J. Erhel, R. Mosé, B. Philippe and P. Ackerer. Numerical Reliability for Mixed Methods Applied to Flow Problems in Porous Media. Computational Geosciences , 6 , pp. 161-194, 2002.

Team 9 Contribution CERFACS

Key scientific staff

Professors: I.S. Duff (5 %), F. Chaitin-Chatelin (5 %, female)
Doctors: L. Giraud (20%), S. Gratton (20%, under 35), M.B van Gijzen (20 %)
Postgraduate students and postdoctoral fellows:
Postdocs: B. Carpentieri (20 %, under 35), D. Loghin (20%)
PhD' sM. Baboulin (10%), E. Martin (10 %, under 35), S. Pralet (10 %, under 35), S. Riyavong (10%, under 35)

The Parallel Algorithms team of CERFACS is one of the leading groups in Numerical Linear Algebra. The team is concerned both with underlying mathematical and computational science research, the development of new techniques and algorithms, and their implementation on a range of high performance computing platforms.

Members of the team play their full part in the wider academic and research community. They are involved in Programme Committees for major conferences, are editors and referees for frontline journals, and are involved in research and evaluation committees. At the level of international efforts for standards in numerical linear algebra, the team has been involved in the development of a new standard for the Basic Linear Algebra Subprograms.
Team members
Iain Duff is the Project Leader of the Parallel Algorithms Team at CERFACS in Toulouse. He is also Group Leader of Numerical Analysis in the Computational Science and Engineering Department of the Rutherford Appleton Laboratory and Visiting Professor at the University of Strathclyde. He is a leading expert in linear algebra and is (co-)author of over 150 journal and proceedings publications, and of 9 books.
Francoise Chaitin-Chatelin is Professor at the Université de Toulouse I and the head of the Qualitative Computing Group hosted in the Parallel Algorithms Team at CERFACS. She is a world expert in the reliability of finite precision computations. She has supervised 30 PhD students and is co-author of five books and of numerous journal publications and reports.
Luc Giraud is a senior scientist and responsible for the research on iterative solution techniques. His research interests include preconditioning techniques for large dense systems, and domain decomposition methods.
Serge Gratton is a senior researcher in charge of the data assimilation and optimization research.
Martin van Gijzen is a senior scientist. His research include iterative solution techniques for finite element systems in structural mechanics, acoustics and oceanography.
Bruno Carpentieri is a postdoctor researcher. He has extensive experience in numerical linear algebra, and its application to electromagnetic problems.
Daniel Loghin is a postdoctoral researcher. His scientific interests include numerical linear algebra and finite element methods with application to fluid dynamics. He has worked on many subjects, including saddle point preconditioners, and the stability of non-normal Navier-Stokes problems.
Emeric Martin is a PhD student working on spectral preconditioners with application to electromagnetic problems.
Stéphane Pralet is a PhD student. His research concerns parallel multifrontal solution methods for sparse systems of linear equations.
Songklod Riyavong is a PhD student working on matrix-partitioning techniques.

Amestoy, P. Berger, P. Dayde, M. Duff, I., Fraysse, V. Giraud, L. and Ruiz, D. (Editors)} (1999). EuroPar'99 Parallel Processing. Lecture Notes in Computer Science, No. 1685, Springer-Verlag, Berlin, Heidelberg, New York.

Duff, I.S. and Vomel, C. (2002). Algorithm 818: a reference model implementation of the Sparse BLAS in Fortran 95. ACM Trans. Math. Softw. Vol 28, nr 2, pp. 268-283.

Team 10 contribution ENSEEIHT-IRIT
The research team at ENSEEIHT-IRIT has a strong experience in the design of numerical software, in high-performance computing, and more recently in grid computing.
The main research areas are :

- Computational kernels for linear algebra and nonlinear optimization
- Sparse direct linear solvers
- Iterative linear solvers
- PDES and domain decomposition
- Parallel computing and Grid computing

The team has been involved in the design of serial and parallel computational kernels such as tuned versions of the BLAS. It has also been involved in the porting of industrial codes (e.g. in CFD) on parallel computers.
There has been much joint work over many years on sparse matrix software between ENSEEIHT-IRIT and others organizations including CERFACS, Rutherford Appleton Laboratory, LaBRI, LIP-ENSL, Parallab, University of Florida, Berkeley.
This has given rise to the production of several software packages that are available to the scientific community. Included among these are:

- Iterative solvers: use of block conjugate gradient, element-by-element preconditioners, row projection techniques.
- The MUMPS software (see http://www.enseeiht.fr/apo/MUMPS) initially developed within the framework of the ESPRIT LTR PARASOL project (1996-1999)
- The codes MA41 (**LU factorisation**), and MA49 (**QR factorisation**) for shared memory multiprocessors available on the Web and/or in HSL (formerly the Harwell Subroutine Library).

We have recently started a grid computing project, the GRID-TLSE Project, in which all the members of the team are involved. This is one of the biggest project funded by the French ministery of education (through the ACI grid program). The goal of the Project is to design an expert site that uses the accumulated expertise just mentioned above and provides a one-stop shop for potential users of sparse codes.

Key scientific staff

- Patrick Amestoy:
  - Area of expertise: sparse direct solvers, parallel computing
  - Involvement : 10%
- Michel Daydé:
  - Area of expertise: high-performance computational kernels for linear algebra and nonlinear optimization, grid computing
  - Involvement : 10%
- Daniel Ruiz: Area of expertise:
  - sparse iterative solvers, PDE, scaling and pre-processing
  - Involvement : 20%
- Ronan Guivarch:
  - Area of expertise: iterative solvers, PDE, domain decomposition
  - Involvement : 20%

Publications

P. R. Amestoy, I. S. Duff, J.-Y. L'Excellent, and J. Koster. A fully asynchronous multifrontal solver using distributed dynamic scheduling. SIAM Journal on Matrix Analysis and Applications, 23(1):15-41, 2001.

M. Arioli, I. S. Duff, D. Ruiz, and M. Sadkane. Block Lanczos techniques for accelerating the Block Cimmino method. SIAM J. Scient. Statist. Comput., 16:1478-1511, 1995.

Team 11 contribution Department of Econometrics, University of Erfurt

The team working on model selection in multivariate and nonlinear systems of equations is located at the department of econometrics at the University of Erfurt. A specific research focus of the department consists in computational statistics and econometrics. The main research areas are: Uniform Design, quasi-Monte Carlo methods, model selection in VAR and VEC-models, quantitative finance.
The department comprises a staff of 2 full-time research and teaching scientists and 2 doctoral candidates. The present proposal is run by the two full-time research scientists and will be

supported by one of the doctoral candidates. Besides their own computational equipment, this research group has access to further facilities at the Technical University in Ilmenau which allow to apply computational intensive methods in statistics and econometrics.
Based on the specific expertise of the researchers in the development and application of heuristic optimization algorithms (like threshold accepting and memetic algorithms) to inherently computational complex problems in statistics, econometrics and economics, their exist several active co-operations related to different applications, e.g. with Kai-Tai Fang (Hong Kong Baptist University, Uniform Design, supported by a DAAD grant), Manfred Gilli (Universite de Geneve, quantitative finance), John Chipman (University of Minnesota, econometric application of threshold accepting), and Jenny Li (Pennsylvania State University, quasi-Monte Carlo methods). These applications are related to the current proposal.

Peter Winker (38, chair professor of econometrics) is involved for 15 % of his time in this proposal. He s advisor of 3 Ph.D. researchers, associate editor of CSDA, and has been involved in research projects for the German government and the OECD. His scientific interests are on solving complex modelling and estimation problems in statistics and econometrics such as experimental design, model selection, aggregation of time series, quasi-Monte Carlo methods, by making use of optimization heuristics.
Dietmar Maringer (35, assistant professor) is involved for 20 % of his time in this proposal. His research interests are in memetic algorithms and the application of optimization heuristics to problems in finance, e.g. portfolio optimization under VaR.
Mark Meyer (31, research assistant) is involved for 20 % of his time in this proposal. He conducts research on multivariate non linear time series models. His specific interest is on the effects of (non) optimal model selection methods on the forecasting performance of these models.

Publications:
Fang, Lu, Winker (2003), Lower Bounds for Centered and Wrap-around L_2-discrepancies and Construction of Uniform Designs by Threshold Accepting, Journal of Complexity 19, 692-711.
Fang, Ma, Winker (2002), Centered L_2-Discrepancy of Random Sampling and Latin Hypercube Design, and Construction of Uniform Designs, Mathematics of Computation 71, 275-296.
Gilli, Winker (2003), A Global Optimization Heuristic for Estimating Agent Based Models, Computational Statistics and Data Analysis 42,3, 299-312.
Maringer, Winker (2003), Portfolio Optimization under Different Risk Constraints with Memetic Algorithms, Discussion Paper No. 2003-005E, University of Erfurt, Erfurt.

Team 12 contribution University of Dortmund

Stefan Turek, full professor (C4) at the University of Dortmund, has published more than 40 papers/conference contributions in the field of FEM methods, multigrid solvers, CFD and high performance computing, including a monograph on incompressible flow solvers (Springer). Besides, he is strongly involved in developing basic FEM software (FEAT, FEAST) and the open-source CFD package FEATFLOW (www.featflow.de). Recently, the main research topics of his group of appr. 25 PhD students, Post-Docs and collaborators is Computational Fluid Dynamics and the development and realization of the Open-source FEM packages FEAT and FEAST

Topics of interest:
Numeric for PDEs, theory and application of Finite Element Methods, Multigrid/Domain Decomposition solvers, Computational Fluid Dynamics (CFD), Computational Structural

Mechanics (CSM), Chemical Engineering, Multiphase flows, High Performance Computing, Hardware-oriented Numeric, Scientific Visualization, Mathematical Software Engineering

Teaching:
Courses in Applied Mathematics, Numeric for PDEs, Scientific Computing, Mathematics for engineers and computer scientists
Organisation of annual "FEATFLOW Summer schools" which are international compact courses for students and post-docs to get familiar with mathematical and algorithmic techniques for Computational Fluid Dynamics, FEM methods and software and the CFD software package FEATFLOW

Publications:
1 monograph (Springer), more than 40 papers/conference contributions in the field of FEM methods, multigrid solvers, CFD and high performance computing
Chief scientist of the Open-Source software package FEATFLOW for CFD (www.featflow.de)

S.Turek: Efficient solvers for incompressible flow problems: An algorithmic and computational approach, LNCSE 6, Springer-Verlag, 1999

Chr. Becker, S. Kilian, S.Turek: Hardware-oriented Numerics and concepts for PDE software, to appear in: Special Journal Issue for PDE Software, International Conference on Computational Science ICCS2002, Amsterdam, 2002

Projects:
Experience with numerous projects in education, research and application with industrial background, mainly based on the FEATFLOW software

Equipment:
Several multi-processor SUN and COMPAQ servers, parallel LINUX cluster (50 nodes), access to national and international parallel supercomputers

Key scientific staff:

Dipl. Math. Mike Altieri	industrial projects, teaching, FEATFLOW courses (25%)
Dipl. Inf. Christian Becker	chief developer of mathematical software packages, parallel high performance computing (10%)
Dr. Jaroslav Hron	computational structural mechanics, fluid-structure interaction, nonlinear fluids (10%)
Prof. Dmitri Kuzmin	CFD, multiphase flows, chemical engineering (10%)
Dipl. Ing. Frank Platte	chemical engineering, industrial applications (20%)
Dr. Ludmilla Rivkind	teaching, FEATFLOW courses (25%)

Team 13 contribution University of Patras, Department Of Computer Engineering & Informatics (High Performance Information Systems Laboratory).
The contribution of this team will be in areas related to the design of kernel methods for computations with matrices and matrix functions; methods for the fast and practical

computation of specific matrix characteristics such as methods and software for the pseudospectrum of parameter dependent matrices; linear algebra and parallel computation in data mining with emphasis on clustering techniques; domain specific problem solving environments and parallelism and Grid computing. The team has been collaborating in efforts with colleagues in the U.S..A. (University of Minnesota; Dr. C. Bekas, Ms. E. Kokiopoulou and Prof. Y.Saad. Purdue University: Prof. A. Sameh) and Europe (IMATI-CNR, Italy: Prof. V. Simoncini; IRISA, Rennes: Prof. B. Philippe; NTUA, Athens: Prof. A. Boudouvis; Dept. Mathematics, Patras: Prof. M. Vrahatis). Several of these topics are attracting the interest of several NUMAS teams (e.g. eigenvalues, singular values and pseudospectra at Oxford, Manchester and IRISA; LSI and parallelism in Salzburg) we will strengthen existing collaborations (e.g. with Bologna and IRISA) and will pursue collaborations with other NUMAS teams engaged in such researches.

The *High Performance Information Systems Laboratory* of the University of Patras was founded in 1990, consolidating activities and R&D projects in parallel and scientific computing. Work in this area was already initiated in 1984, including research, the first courses in parallel computing in Greece, projects funded by the European Union and national agencies, the introduction of a commercial parallel machine for the first time in Greece (Intel iPSC/2 hypercube), as well as the organization of several conferences, most prominently the ACM International Conference on Supercomputing. The laboratory supports research and education in the following areas:

System software for parallel computing. Research includes operating systems, runtime systems and compilers techniques for job scheduling and memory management in shared and distributed memory multiprocessors.

Numerical computing and applications. Research includes numerical methods and software systems for PDEs, problem solving environments, eigenvalue problems and computational finance, science portals, computational finance.

Hypermedia & multimedia environments. Research includes hypermedia frameworks and tools, digital libraries and information repositories, content modelling and metadata, applications in Culture, computer assisted and distance education, 3D/VR systems and user interfaces, intranets and networking infrastructure, e-learning.

In-residence staff includes two full Professors (Professor T. Papatheodorou, Director, and Professor E. Gallopoulos), one Lecturer and more than forty graduate researchers and computer engineers. The laboratory has also established regular collaboration with well-known researchers in other European countries and the U.S. In addition, HPCLAB is the Information Technologies Consultant to the Ministry of Culture of Greece, and has also participated in application development the Ministry of Environment - Physical Planning & Public Works, the Ministry of Education, the Bank of Central Greece, and more. Through specific international projects and research activities the laboratory has established partnership and collaboration with several researchers and organizations outside Greece such as UPC/CEPBA (Barcelona); Istituto di Cibernetica-CNR (Naples); University of Technology (Vienna); IRISA (Rennes); MISAS (Bratislava); CLPP (Sofia); Purdue University (USA); University of Illinois at Urbana-Champaign (USA); University of Minnesota (Minneapolis, USA); Maison des Sciences de l'Homme (Paris); Architekturstiftung (Graz); and more.

The two professors of the Laboratory have graduated a large number of Computer Engineers at the 5 year – Diploma level and the postgraduate Master’s and Ph.D. levels. Graduates of the Department that were members of the Laboratory are currently pursuing postgraduate work at Princeton, Carnegie-Mellon, Minnesota and Purdue.

Several Ph.D. holders from the department that have conducted their theses within the Laboratory are currently employed at postdoctoral and Assistant Professor positions abroad (University of Minnesota, University of Illinois at Urbana-Champaign, College of William and Mary).

Key scientific staff:

Dr. Efstratios Gallopoulos (at 5% of full time employment)
Dr. Michalis Vrahatis (at 5% of full employment)

Experience: Dr. E. Gallopoulos has been Full Professor at the Department of Computer Engineering & Informatics since 1996. His research interests are in the areas of Scientific Computing, Numerical Linear Algebra and its applications, Parallel and Distributed Computing and Problem Solving Environments. Professor Gallopoulos has been Director of the Department's Software Division since 1998. He was staff (Senior Computer Scientist) and faculty member at the University of Illinois at Urbana-Champaign (1986-96). Before that he was Assistant Professor at the University of California Santa Barbara (1985-86); visiting researcher at NASA Goddard Space Flight Center (Summer 1982 & 1983). He has participated as Senior Computer Scientist in research and development of the Cedar vector multiprocessor at the University of Illinois Center for Supercomputing Research and Development (1987-94); participated in the software development of the Goodyear Aerospace Massively Parallel Processor (MPP) (1980-85) receiving a NASA group achievement award (For outstanding initiative and creativity in the development, demonstration, and practical application of the first Massively Parallel Processor). His research has been funded by Esprit, the Greek Secretariat for Research and Technology, the US National Science Foundation, the US Department of Energy and AT&T. He has participated as member in many scientific committees of international conferences and has been editor of Computing in Science and Engineering (IEEE Computer Society and the American Institute of Physics, 1994-99) and of the International Journal of High Speed Computing (1989-today). Professor Gallopoulos is member of the Steering Committee of the European Research Foundation EURESCO Conference on Advanced Environments and Tools for High Performance Computing as well as member of the ACM International Conference on Supercomputing. Professor Gallopoulos received his Ph.D. at the Department of Computer Science of the University of Illinois at Urbana-Champaign and his B.Sc. (First Class Honours) in Mathematics from the Imperial College of Science and Technology (1979).

Dr. Michalis Vrahatis is Professor of Mathematics with expertise and extensive publication record in the numerical solution of nonlinear equations, dynamical systems, neural networks, machine learning, data mining.

Two recent research publications:
C. Bekas and E. Gallopoulos, "Parallel Computation of Pseudospectra by Fast Descent". Parallel Computing, v. 28, pp. 223-242, 2002.
C. Bekas and E. Gallopoulos, "Cobra: Parallel path following for computing the matrix pseudospectrum". Parallel Computing, v. 27, pp. 1879-1896, 2001

Team 14 contribution IMATI, Institute of Applied Mathematics and Information Technology,
Key scientific staff

Professors: F. Brezzi (5 %), G. Sacchi (5 %), V. Simoncini (10% female)
Doctors: G. Manzini (50%), M. Pennacchio (20%, female), G. Sangalli (20 %)
IMATI was founded in September 2000 but it did not start its research activities until March 2002. The current structure of the Institute is a result of the merger of three existing Institutes, which are well known within the field of Mathematics and its Applications, namely: IAMI (Institute for the Application of Mathematics and Computer Sciences) in Milan, IAN

(Institute of Numerical Analysis) in Pavia, and IMA (Institute of Applied Mathematics) in Genoa.
The Institute itself has three divisions (Milan, Pavia and Genoa) with its main offices in Pavia. The merging of the former Institutes into a single one, has enabled IMATI to carry out research activities in numerous fields of mathematics, information technology and their applications:
- Mathematical Statistics and Probability, with research programs focusing on the development and study of methodologies and models for the description of random phenomena, both in parametric and non-parametric frameworks, with applications to pray-predator stochastic models, to decision problems, image analysis, reliability data analysis, seismic data analysis. This field is mainly studied in Milan.
- Graphic Information Technology and Geometric Modelling, with research programs concerned with the development of methods of shape analysis and synthesis applied to CAD, to GIS systems and to techniques of virtual reality, and of methods for curve and surface reconstruction. This field is mainly studied in Genoa, and there are active researchers in Milan as well.
- Computing Architectures and High Performance Computing, with research programs aiming to develop methodologies, algorithms, models and tools for an efficient and effective use of innovative computing architectures. This field is mainly developed in Genoa and in Pavia.
- Information Technologies, with research work concerned with training programs, teaching of scientific subjects, and the development of procedures and programming languages that allow mathematical and scientific documentation to be dealt with via the Internet. Other research deals with the study of models and algorithms for the treatment of evolved data bases and problems of word combinatorics. Researchers from Genoa, Milan and Pavia are involved in this field.
- Modelling of Biomedical Phenomena, with research programs concerning the development and study of methods for problems arising in electrocardiology as well as problems of identification of biological and physical systems. The modelling approach based on the coupling of qualitative analysis techniques with fuzzy logic techniques are particularly interesting in this field. Researchers from Pavia are mainly involved in this field.
- Differential Modelling, which is considered from different points of view: theoretical (existence, uniqueness and regularity of the solutions), numerical (approximation schemes, stability and adaptability) and computational (algorithms and computing methodologies).
The results of these basic research programs are widely used to deal with application problems coming from, for instance, fluid dynamics, analysis of electromagnetic and semiconductor devices, and the study of the elastic properties of materials. This field is mainly studied in Pavia, and there are active researchers in Genoa and Milan as well.
Within IMATI the strengths of the three different components of which it is made up, give rise to an innovation both in the basic research activities as well as the applied research ones. In fact within the same institute the expertises vary from theoretical and computational modelling to informatics and from probability and statistics to teaching and training activities. The synergetic grouping together of these abilities allows the institute to deal with the changing needs of applied research as well as increasing its contribution in the field of basic methodology.

Two Most Significant Recent Publications

F. Brezzi, L. D. Marini, S. Micheletti, P. Pietra, R. Sacco: Stability and error analysis of mixed finite volume methods for advection-diffusion problems. Tech. Rep. 1-PV, IMATI-CNR, 2003.
M. Pennacchio and V. Simoncini, Efficient algebraic solution of reaction--diffusion systems for the cardiac excitation process. J. Comput. Applied Math., v.145 (1) (2002), pp.49-70.

Team 15 contribution IAC-CNR section of Bari

The Istituto per le Applicazioni del Calcolo “M. Picone”, Consiglio Nazionale delle Ricerche, sez. Bari (IAC-CNR, Bari) carries out research in various areas of numerical analysis.
There are 7 permanent members of staff and frequent visitors.
IAC-CNR, Bari organizes an international summer school in Numerical Linear Algebra and its Applications, workshops and conferences.
IAC-CNR, Bar has close links with the Department of Mathematics of the University of Bari.

Key scientific staff and Research Interests

The research interests of the group fall broadly into two areas:
linear algebra and computational fluid dynamics.

Dr Nicola Mastronardi

Mastronardi works in numerical linear algebra and its applications,
with particular interests in (structured) total least squares problems and eigenvalue problems. This work encompasses theory, the derivation of algorithms, and software development.

Dr Fasma Diele

Diele's research interests are in numerical approximation of conservative ordinary differential equations and linear algebra problems, n particular direct and inverse structured eigenvalue problems.

Dr Laurent Gosse

Gosse's research interests are in numerical simulation and analysis of hyperbolic balance laws.

Dr Antonio Lamura

Lamura's research interests are in the kinetic-modelling of non-ideal fluids using kinetic particle methods, particularly Lattice Boltzmann and Monte Carlo methods, and convection-diffusion equations.

Dr Carmela Marangi

Marangi's research interests are in statistics and neuro-fuzzy systems with applications in Physics and Biology.

Dr Filippo Notarnicola

Notarnicola's research interests are in subsoil computational fluid dynamics and subsoil multiphase flows.

Dr Christian Skaug

Skaug's interests are in stochastic dynamics, numerical methods, financial mathematics and petroleum reservoir modelling.

Two Most Significant Recent Publications

P. Lemmerling, N. Mastronardi, and S. Van Huffel, Efficient implementation of a structured total least squares based speech compression method, Linear Algebra and its Applications, 366, pp.295-315, 2003.
A. Xu, G. Gonnella and A. Lamura,
Phase-separating Binary Fluids under Oscillatory Shear, **Phys. Rev. E**, 67, pp.1-14, 2003.

Team 16 contribution Dipartimento di Matematica Universitá di Roma “La Sapienza”

Key scientific staff, available 10-20%.

Dr. Daniele Bertaccini
Prof. Pasquini

Expertise:

- Numerical linear algebra, in particular iterative solvers for large sparse linear systems or eigenvalue problems and their preconditioning.
- Large-scale scientific and parallel computing.

- The application of multilevel and multiscale approaches.

We have collaboration at Roma "La Sapienza" with physicists and engineers for the solution of extremely large systems of Equations. We are involved in a 11.9 million dollar funded by NIH project for modelling of metabolism (MIMS center, Case Western Reserve University, Cleveland).

We have recently lectured at Roma "La Sapienza" on the following topics:

- Introductory computer science (PA)
- Iterative methods for linear systems (MG)
- Linear algebra (MG)
- Preconditioning (MG)
- Solution of large scale eigenvalue problems (PA)
- Numerical solution of partial differential equations

Infrastructure/facilities:

There is some office space available with up-to-date computer equipment and high-speed interconnect.

Two selected publications:

D. Bertaccini, ``The spectrum of circulant-like preconditioners for some general linear multistep formulas for linear boundary value problems", SIAM J. Numerical Analysis, vol. 40-5, pp.1798-1822, 2002.

M. Benzi, D. Bertaccini, “Approximate inverse preconditioning for shifted linear systems”, BIT, vol. 43, pp. 231-244, 2003.

Team 17 contribution Center Centre de Recherche Public Henri Tudor -(L)
Short name: CRPHT-LU
E-mail: salim.belouettar@tudor.lu
Website: http://www.tudor.lu

Director : Dr. Jos Schaefers

The Centre de Recherche Henri Tudor (H. Tudor) is the largest public research laboratory in Luxembourg with over 200 researchers. It operates co-operations with the University of Luxembourg, technical consulting companies and private companies. The laboratory is made up of a modelling unit, a material sciences unit, a mechatronics unit and a production and logistics unit. Laboratory of industrial technologies was founded to support local industries at performing simulations, structural analysis, data analysis and material sciences. Within the laboratory, finite element codes, CAD systems and programs of integrated design are used for the solution of technological problems and the validation of new algorithms which are developed in the laboratory, which provides it has considerable experience in modelling, simulation, optimisation, systems control and mechanical testing.

The research activities of the modelling team are highlighted by various projects carried out in the field of computational mechanics, process modelling and data processing. Currently, we are interested in large deformation mechanics, impact and damage, composite materials, homogenization and the constitutive modelling of non-linear materials.

Key scientific staff and Research Interests
The research interests of the group fall broadly into two areas:
Computational Mechanics Data Analysis and.

Dr Serge Gillé
Dr. Gillé's research interests are in fluid mechanics, statistics, control and fuzzy systems with applications in Physics and Environment.

Dr Salim Belouettar
Dr. Belouettar's research interests are in finite element method and analysis, constitutive modelling systems with applications in Physics and Environment.

Dr Gaston Rauchs
Dr. Rauchs's research interests are in mechanical modelling using the finite element method and mechanical parameter identification by implementing optimization methods in finite element program codes.

George Schutz
Schulz research interests are industrial processes modelling using neural network.

Recent Publication:

S.Belouettar, Euromat2003 Conference Lausanne (1-5 September 2003). Finite element modeling Car seat Foams

G. Rauchs, M. Preuss, and P.J. Withers, Micromechanical Analysis of Internal Stress Development during Single-Fibre Fragmentation Testing of Ti/SiCf, Acta Mater. 50, 2002, 2477-2490

Team 18 contribution University of Bergen (UiB)

Parallab is the Laboratory for Parallel Computation of UiB (Norway) and is organized as a unit of the Bergen Center for Computational Science (BCCS). Parallab conducts research in high performance computing, with a special emphasis on cross-disciplinary and industrial research, applied research in parallel and distributed computation, and projects with other branches of sciences. Parallab also conducts research on applied mathematics that underpins many of today's simulations in the various computational sciences. These include numerical methods for differential equations, linear algebra, distributed programming and algorithms and grid-enabling environments. Parallab also provides teaching and training in parallel and distributed programming and has over the years trained many PhDs and post-docs, hosted advanced courses and workshops, while building on the existing educational programme in computational science at UiB.
Parallab also operates and provides the user-support for the supercomputer facilities of UiB. These are currently a cluster of three 32-way IBM p690 Regatta SMP nodes (500 Gflops/s) and a 32-node IBM 1300 cluster (81 Gflops/s).
Parallab receives funding from the European Union (5th and 6th Framework), the Research Council of Norway, and from various national and international research and industrial organizations. Parallab currently has six permanent scientific staff members.
Parallab maintains active collaborations with other units at BCCS. These include computational biology (functional genomic), computational mathematics (geophysics and

hydrodynamics), and computational physics (reaction modelling). BCCS is co-located with the Department of Informatics of UiB and maintains close relations with the departments of Mathematics, Physics, Geophysics, and Molecular Biology.

Key scientific staff and Research Interests
Professor Petter E. Bjørstad, Dr Jacko Koster
The research interests of Parallab that are of interest to this application fall into linear algebra and differential equations and high-performance scientific computing.
Bjørstad and Koster work in numerical linear algebra and its applications. They have particular interest in domain decomposition and the solution of large sparse linear systems of equations. This includes the design of numerical algorithms, software development and applications of these in large-scale industrially oriented simulations. Bjørstad is Research Director of BCCS and Group Leader of Parallab.

Two Most Significant Recent Publications

P. R. Amestoy, I. S. Duff, J. Koster, and J.-Y. L'Excellent. A fully asynchronous multifrontal solver using distributed dynamic scheduling. SIAM J. Matrix Anal. Appl., 23(1):15-41, 2001.

P. Bjørstad, M. Dryja, T. Rahman. Additive average Schwarz methods for elliptic mortar finite element problems. Numerische Mathematik, 95(3):427-457, 2003.

Team 19 contribution Institute of Mathematics, Dept. of Informatics, Slovak Academy of Sciences

Main research topics of the research team, composed of the researchers from the Institute of Mathematics, Dept. of Informatics, Slovak Academy of Sciences, Bratislava, Slovakia, include:

- Design of efficient parallel algorithms for the eigenvalue/singular value decomposition (EVD/SVD) of matrices, covering both the complete SVD (Jacobi methods for dense matrices) and the partial SVD (iterative methods for sparse matrices).
- Analysis of the computational and communication complexities of designed parallel algorithms. Implementation of designed parallel algorithms on the distributed/shared memory parallel computers.
- Applications of the EVD/SVD mainly in the (total) least squares computations and signal processing.

These activities are very close to those of the research team at the Salzburg University (Prof. Marián Vajteršic), Salzburg, Austria, and of the research team at the Institute of Computer Science (Prof. Zdeněk Strakoš), Academy of Sciences of the Czech Republic, Prague, Czech Republic. There are possible connections to the research teams in other countries, too.
Gabriel Okša (MSc, PhD) graduated in mathematical engineering from the Czech Technical University, Prague, Czech Republic, in 1982. He received his PhD degree in computer science from the Slovak Academy of Sciences, Bratislava, Slovak Republic, in 1992. He is a holder of the Royal Society Fellowship in years 1995-1997, and he took part as a researcher in the international projects within the ESPRIT and COPERNICUS Programme of the European Union (years 1993-2000), and in the NATO Collaborative Linkage Grant (years 2000-2002). He managed his own MINOS project (EU) at the C.I.N.E.C.A. in Casalecchio di Reno, Italy (September—October 2001).

Martin Bečka (MSc, PhD) graduated in theoretical cybernetics, mathematical informatics and theory of systems from the Comenius University, Bratislava, Slovak Republic, in 1991. He received his PhD degree in the applied informatics at the Comenius University in January 2003. He managed his own MINOS project (EU) at the C.I.N.E.C.A. in Casalecchio di Reno, Italy (February—March 2002) and has taken part in international projects within the ESPRIT, COPERNICUS Programme and NATO Scientific Programme (years 1993-2002). Currently he holds the post-doc position at the ETH, Zurich, Switzerland.
Laura Husárová (MSc) graduated in the theoretical cybernetics and mathematical informatics at the Comenius University, Bratislava, Slovak Republic, in 1981. She is involved in the programming, testing and implementation of the efficient parallel linear algebra algorithms.

Recent publications include:
M. Bečka, G. Okša and M. Vajteršic, Dynamic ordering for a parallel block-Jacobi SVD algorithm, **Parallel Computing** 28 (2002) 243-262.
G. Okša and M. Vajteršic, A systolic block-Jacobi SVD solver for processor meshes, **Parallel Algorithms and Applications** 18 (2003) 49-70.

Team 20 contribution Linköping University
The research in Scientific Computing at the Department of Mathematics is focused in the following areas

- Numerical linear algebra with applications in data-mining, signal processing, and image reconstruction.
- Numerical solution of inverse problems for partial differential and integral equations with applications in thermal engineering.

The following persons are involved in the research:

- Lars Elden, full professor
- Tommy Elving, associate professor
- Ake Bjorck, professor emeritus
- Fredrik Berntsson, post-doc researcher (inverse problems)
- Lennart Simonsson, PhD student (numerical linear algebra)
- Zohreh Ranjbar, PhD student (inverse problems)
- Berkant Savas, PhD student (data mining, numerical linear algebra)
- Ingegerd Skoglund, instructor and PhD student (numerical linear algebra)

The group collaborates with researchers in Linköping and several European countries.
Recent publications include:

L. Eldén: Partial Least Squares vs. Lanczos Bidiagonalization I: Analysis of a Projection Method for Multiple Regression. Comp. Stat. Data Anal. to appear, 2003.

T. Elfving and Y. Censor: Block-iterative algorithms with diagonally scaled oblique projections for the linear feasibility problem, SIAM J. Matrix Anal. Appl., to appear.

Team 21 contribution ETHZ Zurich

Key scientific staff, available 10-20%.
Prof. Dr. Peter Arbenz
Swiss Federal Institute of Technology
Institute of Computational Science
ETH Zentrum HRS G 27
8092 Zurich

Prof. Dr. Martin Gutknecht
Swiss Federal Institute of Technology
Seminar for Applied Mathematics
ETH Zentrum HG G 52.2
8092 Zurich

Expertise:

- Numerical linear algebra, in particular iterative solvers for large sparse linear systems or eigenvalue problems and their preconditioning.
- Large-scale scientific and parallel computing.
- The application of multilevel and multiscale approaches.

We have extended collaboration at ETH with physicists and electrical engineers regarding the solution of extremely large systems of equations from semiconductor device and circuit simulation and of extremely large eigenvalue problems arising in the design of cavities of particle accelerator or lasers.
We have recently lectured at ETH on the following topics:

- Introductory computer science (PA)
- Iterative methods for linear systems (MG)
- Linear algebra (MG)
- Numerical parallel computing (PA)
- Preconditioning (MG)
- Solution of large scale eigenvalue problems (PA)

Infrastructure/facilities:
There is sufficient office space available with up-to-date computer equipment and high-speed interconnect.
There is access to large-scale computing facilities:
a 500+ processor Beowulf cluster
a 64 processor HP Superdome machine
a 8 node (256 CPU) Regatta IBM SP4

Publications:
M.H.Gutknecht: Lanczos-type solvers for nonsymmetric linear systems of equations. Acta Numerica 6: 271-397 (1997).
P. Arbenz and Z. Drmač: "On Positive Semidefinite Matrices with Known Null Space". SIAM J. Matrix Anal. Appl. 24 (1): 132-149 (2002).

Team 22 contribution Department of Computer Science, University of Basel
The Scientific Group of the Department of Computer Science, University Basel, Switzerland (UNIBAS) will be engaged in research concerning direct and multilevel-algebraic iterative linear solution methods for general unsymmetric linear systems, and sparse singular value decomposition methods for challenging industrial simulation problems from semiconductor device simulation, circuit simulation, sheet metal forming and biomedical applications. UNIBAS is part of a recently established initiative on Computational Sciences at the University of Basel, Switzerland (www.computational.unibas.ch). The research of the group is targeted on the development of algorithms and programs for solving geometric, numerical and high performance problems in Computational Sciences and Engineering. One central part of the research aims at the solution of general sparse systems of linear equations by robust direct and multilevel-algebraic iterative methods. Special emphasis is placed on the application of the methods to challenging industrial problems like semiconductor device simulation, circuit simulation and crash forming simulation. Whenever possible, the projects include applications with users outside the core area of computer science and mathematics. Part of the current projects are done in international industrial cooperation. The Scientific Computing Group is currently involved in the following research collaborations:
Project "Algebraic Multilevel Methods for the Solution of Large Sparse Linear Systems of Equations from Sheet Metal Forming Process Simulation" supported by the Swiss Commission on Technology and Innovation and AutoForm Engineering AG.
Research collaboration "Towards Robust Algebraic Multigrid Methods with Sparse Direct Solver Technology for Semiconductor Device Simulation Matrices" supported by Integrated Systems Engineering AG, Zurich, Switzerland, the Intel Software Research Lab, Oregon, US and the IBM Thomas Watson Research Lab, Yorktown Heights, US.
Project "Large Scale Eigenvalue Problems in Opto-Electronic Semiconductor Lasers and Accelerator Cavities" supported by the Strategic Excellence Projects of the Swiss Federal Institute of Technology, ETH Zurich
The research of UNIBAS has resulted into the sparse matrix solver library PARDISO (www.computational.unibas.ch/cs/scicomp) that includes direct and iterative algorithms. PARDISO is an industrial-strength implementation of parallel sparse solver technology. The solver of UNIBAS is recognized as a useful tool and the close industrial cooperation's have substantially influenced the capabilities of the world-wide used solver (both for research and commercial applications). UNIBAS will closely cooperate with the European industrial technology partners NEC CCRLE Research Laboratory, Integrated Systems Engineering AG (ISE AG) and AutoForm Engineering AG (AutoForm AG) for transfer of knowledge in Numerical Linear Algebra and Large Scale Scientific Computing. Furthermore the current intensive cooperation with ISE AG regarding advanced semiconductor device simulation techniques and AutoForm Engineering AG concerning automobile simulation techniques (linear solver, nonlinear optimization methods) will generate an ideal basis for further cooperation in this research training network.

Key Scientific Staff: Dr. Olaf Schenk (100 %)

Olaf Schenk received his Diploma degree in applied mathematics and computer science from the University of Karlsruhe, Germany in 1996 and his Ph.D. degree in technical sciences from the Swiss Federal Institute of Technology (ETH), Zurich, Switzerland in 2000. Since 2001 he is a Research Associate and Lecturer at the Computer Science Department of the University in Basel, Switzerland. In the second half of 2002 he was an academic visiting scientist at the Mathematical Science Department, IBM T.J. Watson Research Lab, Yorktown Heights, NY. His current areas of research interests include scientific computing, numerical linear algebra, multilevel methods, optimization, computational grids and its applications to engineering problems.

O.Schenk, S. Röllin and A.Gupta. The Effects of Nonsymmetric Matrix Permutations and Scalings in Semiconductor Device and Circuit Simulation, IEEE Transactions on Computer-Aided Design of Integrated Circuits and Systems, Accepted, in press
O.Schenk, and K.Gärtner. Solving Unsymmetric Sparse Systems of Linear Equations with PARDISO, Journal of Future Generation Computer Systems. Accepted , in press.

Team 23 contribution The Matrix Computations and Statistics (MCS) Group University of Cyprus and Université de Neuchâtel (http://iiun.unine.ch/matrix/).

Currently, the Matrix Computations and Statistics (MCS) group is based at the Computer Science Institute, University of Neuchâtel. It consists of Erricos John Kontoghiorghes and four Ph.D. research assistants. From the summer 2004 the MCS group will be moved at the University of Cyprus. The MCS group is active in the following research areas:

1. Numerical solution of large-scale linear econometric models;
2. Computational intensive methods for statistical model selection;
3. Parallel strategies for matrix computations (theoretical aspects);
4. Parallel computing and applications (implementation aspects).

The MCS group has had many papers published or accepted for publication in international journals. The group is involved in various activities in the interface area of parallel computing, numerical linear algebra and computational statistics & econometrics. At national level the group has established links for collaborative research with the Econometrics Department, University of Geneva and the Institute of Scientific Computing at EZHZ. The collaboration with the University of Geneva is involved with the solution of intensive statistical model selection problems, while with ETHZ the collaboration aims to design and analyse novel numerical algorithms for solving large scale econometric models. This research collaboration is currently supported by two Swiss National Science Foundation projects.
Erricos John Kontoghiorghes (PhD London, 1993) is involved 30% of his time in this proposal. He is a senior lecturer & researcher at the Computer Science Institute, University of Neuchâtel, Switzerland, and visiting professor at the school of Computer Science, Birkbeck College, University of London, UK. He will join as Associate Professor the Department of Public and Business Administration, University of Cyprus in the summer of 2004. He is the advisor of four Phd Students, and an ERCIM postdoctoral research fellow. He is the co-founder and co-chair of the ERCIM Working Group on Matrix Computations and Statistics. He is the Co-Editor of the journal *Computational Statistics and Data Analysis* (http://www.elsevier.nl/locate/csda), Editor-in-Chief of the new Handbook series on *Computing and Statistics with Applications* and editorial board member of other journals and book series. He has edited more than 15 special issues of journals, edited volumes of book series and handbooks. He is an elected council member of the International Association for Statistical Computing which has more than 500 members.

Team 24 contribution University of Cardiff
Cardiff will act as a host institution within the network, and will be able to host participants who build on our research strengths and strategy. Any suitable candidate coming to Cardiff will be hosted by the School of Computer Science and the Welsh eScience Centre. Our research focuses on the following areas:

- High Performance Computing

- Collaborative Environments
- Numerical Computing and Computer Simulation
- Grid Computing

Our groups is involved in the FP5 GridLab project (IST-2001-32133), which is focusing on developing an easy-to-use, flexible, generic and modular *Grid Application Toolkit* (GAT), to enable a variety of applications to make innovative use of global computing resources. The project is grounded by two principles, (i) the *co-development* of infrastructure with real applications and user communities, leading to *working* scenarios, and (ii) *dynamic* use of Grids, with self-aware simulations adapting to their changing environment. Currently, two particular application scenarios have been tested, (1) coalescing galaxy formation in astrophysics, and (2) analysis of Gravitational Wave data obtained from the GEO-LIGO experiment (consisting of a range of radio interferometers). Workflow plays a significant part in the GridLab project, to enable applications to be composed from a variety of different components (which may be Java objects or Web Services). GridLab has been seen as a significant project by the Grid Community, and a tutorial on this project was requested at the Globus World meeting in San Diego, January 2003. The GridLab project defines a workflow environment called Triana, and tools and libraries developed the project will be integrated with the Triana system, so that this workflow environment can generate provenance data.
Cardiff is also involved in the UK eScience program, and hosts a regional eScience centre. Through this centre, we participate in a number of research and industrial projects – more details of these can be obtained from http://www.wesc.ac.uk/.
The following participants will be involved in this project from Cardiff:

Omer F. Rana (o.f.rana@cs.cardiff.ac.uk) is a Senior Lecturer in the Department of Computer Science at Cardiff University, and the Deputy Director of the Welsh eScience Centre. He also acts as a technical advisor to "Grid Technology Partners" (www.gridpartners.com) - a US based company specialising in Grid technology transfer to industry. He works in the areas of high performance distributed computing, multi-agent systems and Data Mining.

David W. Walker (david@cs.cardiff.ac.uk) is Professor of High Performance Computing in the Department of Computer Science at Cardiff University (rated 5A in the 2001 RAE), where he heads the Parallel and Scientific Computing group. He is also director of the Welsh eScience Centre. He has conducted research into parallel and distributed software environments for the past 16 years, about 10 years of which time was spent in the United States, and has published over 100 papers on these subjects. Professor Walker played a leading role in initiating and guiding the development of the MPI specification for message-passing, and co-authored a book on MPI. Professor Walker also was a lead designer of the ScaLAPACK library for parallel numerical linear algebra computations. Professor Walker serves on the editorial boards of "Concurrency and Computation: Practice and Experience" journal, and the "International Journal of Higher Performance Computing Applications".

Ian J. Taylor (i.j.taylor@cs.cardiff.ac.uk) is a lecturer in Computer Science at Cardiff University, and the chief architect of the Triana workflow engine. Triana is currently being used as the core workflow engine in GridOneD and the European/IST GridLab project. He is the both the GridLab secretary of the technical board and a member of the steering committee. Dr Taylor's research interests include Grid computing and P2P computing.

Two of our Most Significant Recent Journal Publications

Engineering High-Performance Legacy Codes as CORBA Components for Problem-Solving Environments, M.Li, D.W.Walker, O.F.Rana, Y.Huang, P.T.Williams, and R.C.Ward, Journal of Parallel and Distributed Computing, 63, pp 1152-1163, 2003. Academic Press

Pattern Operators for Grid Environments, M. Cecilia Gomes, Omer F. Rana, and Jose C. Cunha, Journal of Scientific Programming, 11, pp 237-261,2003. IOS Press.

Team 25 contribution Collective Expertise of the Network Teams University of Manchester (UMAN)}

The Manchester Centre for Computational Mathematics (MCCM), located in the Department of Mathematics, carries out research in various areas of numerical analysis. There are 4 permanent members of staff, plus researchers and frequent visitors.

MCCM runs a year-round seminar series, organizes conferences, and runs a M.Sc.\ in Applied Numerical Computing supported by a Master Training Package from the Engineering and Physical Sciences Research Council (EPSRC) funded at £564,602 for 2002-2007, with approximately 12 M.Sc.\ students per year.

At any one time, MCCM has about 5 PhD students working in numerical analysis. Students benefit from the Graduate Training Programme of the University's *Graduate School of Science, Engineering and Medicine*, which provides a structured framework of training activity for graduate research students, intended to complement the research activity.

MCCM has close links with the Centre for Novel Computing in the Computer Science Department.

Key scientific staff and Research Interests

The research interests of the group fall broadly into two areas: linear algebra and differential equations.

Professor Nicholas J. Higham, Dr Françoise Tisseur

Higham and Tisseur work in numerical linear algebra and its applications, with particular interests in (structured and generalized) eigenvalue problems, matrix functions, linear equations, and rounding error analysis. This work encompasses theory, the derivation of algorithms, and software development. Many of the algorithms have been incorporated into the mathematical software package MATLAB (The MathWorks, USA).

Dr Tony Shardlow

Shardlow's interests are in stochastic differential equations, including the development and analysis of efficient numerical algorithms for their simulation and the construction of mathematical theories for the underlying equations.

Dr Christopher A. H. Paul

Paul's research interests are in delay, neutral and delay integro-differential equations, including applications to mathematical modelling in cell proliferation and in economics, and parameter estimation in mathematical models, and include development of algorithms and software.

Two of our Most Significant Recent Journal Publications

1. F. Tisseur and N. J. Higham. Structured pseudospectra for polynomial eigenvalue problems, with applications. SIAM J. Matrix Anal. Appl., 23, pp187-208, 2001.
2. T. Shardlow, Splitting for Dissipative Particle Dynamics, SIAM Journal on Scientific Computing, Volume 24, Number 4, pp.1267-1282, 2003.

Team 26 contribution Oxford University

The Numerical Analysis Group in the Computing Laboratory (the Oxford University Computer Science Department) has one of the larger groups of active Numerical Analysis researchers in the UK. There are currently 8 permanent members of staff and many research students, post-docs and visitors.

Together with the Oxford Centre for Industrial and Applied Mathematics (which is in the

Mathematics Department), the Group runs two Master of Science courses in 'Mathematical Modelling and Scientific Computing' and 'Applied and Computational Mathematics'. These courses which are supported by significant funds from the Engineering and Physical Sciences Research Council (EPSRC) and attract extremely well qualified students from Britain, many countries of the European Union, North America, and more occasionally from Asia and Africa also. Currently there are 30 students on these courses. The Group currently has 21 DPhil (PhD) students.

Key scientific staff and Research Interests

The research interests of the group cover most of the areas of Numerical Analysis: Differential Equations, Linear Algebra, Optimization and Approximation Theory.

Professor Nick Trefethen has broad interests in Eigenvalue problems, non-normality, spectral methods and Complex approximation.

Dr Dominic Donnelly is interested in free and moving boundary problems.

Dr David Gavaghan head the University' s Doctoral Training Centre at the Interface with the Life Sciences and is interested in modelling and simulation in various Physiological problems.

Professor Mike Giles heads the University Technology Centre in Computational Fluid Dynamics and is an Associate Director of the Oxford eScience Centre. He has research interests also in Computational Finance.

Dr Raphael Hauser is an expert in Optimization.

Dr Ian Sobey works on numerical techniques for Incompressible Fluid Flow problems.

Professor Endre Suli is an authority on the analysis of numerical approximation methods for differential equations, in particular finite element methods.

Dr Andy Wathen works on Numerical Linear Algebra and methods for Partial Differential Equations, in particular Iterative methods and Preconditioning.

Two of our Most Significant Recent Journal Publications

1. M.B. Giles and E. Suli. "Adjoint methods for PDEs: a posteriori error analysis and postprocessing by duality". Acta Numerica 2002, pages 145-236, Cambridge University Press, 2002.

2. T.G. Wright and L.N. Trefethen, "Large-scale computation of Pseudospectra using ARPACK and EIGS", SIAM J. Sci. Comput. Vol 28 pp. 591-605, 2001.

Team 27 contribution University of Strathclyde (USTRATH)

The Numerical Analysis Group, part of the Department of Mathematics at the University of Strathclyde, is one of the largest in the UK, with 8 permanent members of staff and a visiting professor. There is research expertise in various areas of numerical analysis, particularly in linear algebra and the solution of differential equations. At any one time, the group has around five PhD students and two post-doctoral researchers working in numerical analysis.

As well as being responsible for the provision of undergraduate teaching in numerical analysis, the group maintains an active research programme including reading courses, postgraduate lectures and an internal seminar series (run jointly with the Industrial Mathematics Group). In addition, the staff coordinate several grants and organize many conferences, including the annual Scottish Computational Mathematics Symposium (organised jointly with Heriot-Watt University).

Key scientific staff and Research Interests

The research interests of the group fall broadly into two areas: linear algebra and differential equations (ordinary, partial and stochastic).

Professor Desmond J. Higham

Higham' s recent research focuses on stochastic computation. He works on numerical methods

for stochastic differential equations and algorithms for extracting structure from large networks. He has applied his results to bioinformatics and mathematical finance.

Dr Philip Knight

Knight works in numerical linear algebra and its applications. His particular interests are rounding error analysis, the effects of nonnormality on numerical algorithms and applications involving Markov chains. This work mixes theory with algorithmic development.

Dr John Mackenzie

Mackenzie's interests are in the adaptive numerical solution of partial differential equations. In particular he works on moving mesh methods and their application to problems in fluid dynamics, material science and heat transfer.

Dr Alison Ramage

Ramage has expertise in the field of numerical linear algebra, specifically in preconditioned iterative solution techniques for linear systems arising from discretizations of partial differential equations. This includes development of theoretical ideas as well as experience of large industrial simulations.

Two Most Significant Recent Publications

Beckett, G., Mackenzie, J.A., Ramage, A. and Sloan, D.M. *Computational solution of two-dimensional unsteady PDEs using moving mesh methods*, Journal of Computational Physics 182, pp 478-495, 2002.

Higham, D. J. *A matrix perturbation view of the small world phenomenon*, SIAM Journal on Matrix Analysis and Applications 25, pp 429-444, 2003.

B3.2 Intensity and quality of the networking

The main objective of the network is to give to the early-stage and experienced researchers the opportunity of building a broad personal system of relations within the European academic world in the fields of computational mathematics and statistics. To achieve this objective, we plan that at least two teams in the network must share the responsability of the training of each of the early-stage researchers and that the experienced researchers must spend at least a semester in visiting at one or more teams in the network to improve her/his competences and to strengthen the level of cooperation. We consider that these average amounts of time will nicely balance the need of individual training and the level of involvment in the network-wide research activities.

We plan the creation a **Research and Training Coordination Board** (RTCB see Section B4.1). The presence of RTCB will shorten the decision time and will cut unnecessary layers of decision. The scientific steering committee will supervise the fulfilment of the above requirements and stimulate (if it will be necessary) the cross-fertilization process by indicating possible training stages in other teams. Moreover, it will be the reference point for the less experienced teams in their decision making and in their integration processes.

The RTCB will also arbitrate any situation involving special needs for a early-stage researcher in conjunction with ERCIM.

B3.3 Relevance of the partnership composition

More than 60% of the teams are members of the two ERCIM Working Groups “Application of Numerical Mathematics in Science” and “Mathematics and Statistics”. The remaining 40% have been and/or are involved in collaborations with other teams in the network. The collaboration with industry is significant. Several of the teams have institutional relationships with the industrial world like H. Tudor center and CERFACS and they are partially financed by a pool of industries.

Some of these industrial partners have expressed an interest in a light form of involvement in

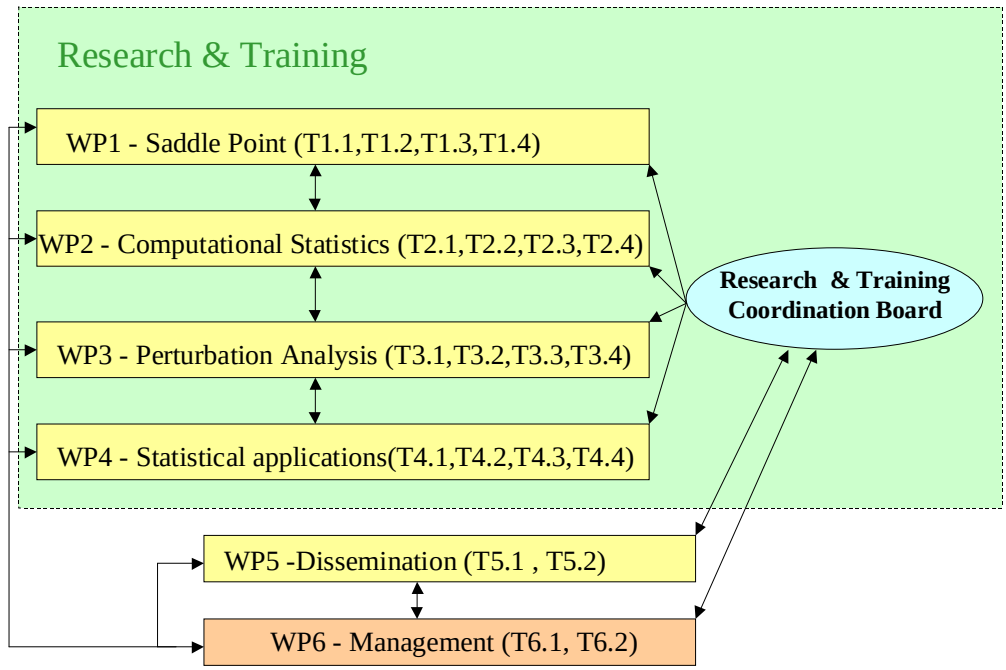
the project. We plan to invite members of the industrial R&D community as lectures of our workshops and summer schools.
Within the network, there are already established sub-networks of specialist nature. The whole project aims to interconnect these pre-existing sub-networks in a more stable way. This will specially benefit the small teams and the teams of the associated States that will have the opportunity of building more durable and sustainable relationships with the other European teams and with European industry.

B4 Management and feasibility

B4.1. Proposed management and organisational structure

The partners involved in this proposal already form a **multi-disciplinary** consortium relying on teams assigned to bring their **expertise to the training network and to the students**. While the training teams involved will focus scientific agenda and training within NUMAS, ERCIM will be the management structure ensuring the administrative and financial co-ordination of the network.

The general management structure of the network is as follows:



The NUMAS management organisation will rely on a coherent architecture organised around 6 work packages. WP1 to WP4 will be addressing the joint research and training agenda, backed up by the Research and Training Co-ordination Board (RTCB). WP5 will be dedicated to the dissemination efforts to be conducted within and outside the network. WP6 will be ensuring the general management of the project, performing the administrative and financial go-ordination.
Research and Training Coordination Board consisting of experts from each field of interest and from industry. The major role of the RTCB will be to identify, define and stimulate initiatives that span several areas, to select common research activities and dissemination initiatives such as workshops, seminars, and the financial support to the young researchers to international conferences. Moreover, we must forecast the possibility of critical situations concerning the fellowships and, thus, the RTCB will also take care of scientific arbitrate and advise to the young researchers.

Research and Training Co-ordination Board (RTCB)

While WP1, WP2, WP3 and WP4 will be conducting their respective agenda as described in the previous parts, the RTCB will be the cornerstone of the whole research and training activities:

Composition: the RTCB is composed of the **scientific co-ordinator, Dr Mario Arioli**, also chairing the ERCIM Working Group "Applications of Numerical Mathematics in Science", and of all the work package leaders. The scientific co-ordinator chairs the board and all decisions are taken by a majority vote-seeking consensus. The RTCB will consider also the possibility of inviting an external member of international outstanding mathematical prestige and educational experience from outside the network and the EU as an advisor on international cooperation with non-European institutions.
Objectives: The RTCB is designed to ensure and assess **the quality of the network's research and training**. It is also to take necessary measures to insure that the network fulfils its ambitions, to perform **transversal scientific co-ordination** of the scientific and training activities among WP1, WP2, WP3, and WP4. The RTCB is also to exploit the network potential and complementarity to add value to the training of researchers. Finally, the RTCB will **review the official deliverables**, to identify and **implement all potential changes** in the network work-plan and to promote the **integration of different research teams** on the underlying scientific priorities of the network.
Tasks: to supervise and stimulate the overall research and training activities while fostering exchanges and interactions among the scientific workpackages. In particular, the RTCB will coordinate the activities of the PhD students with special attention to the legal and institutional aspects concerning the fulfilment of their duties vies a vies to the European University responsible for awarding the title of Doctor of Philosophy. Moreover, when legally possible, we will encourage the recognition of the PhD title by an other European University participating in the Network and involved in the training of the candidate. The RTCB will define the students selection requirements for all partners and co-operate with the ERCIM office in charge of implementing the selection and integration of young researchers. The RTCB is also to discuss the multidisciplinary scientific orientations and to assess the quality of the network's achievements as an internal peer review committee.

Means: being workpackage leaders, the RTCB members will participate to bi-annual meetings organised to assess the overall achievements of the network. Members will perform an overview of their respective activities as WP leaders and the Board will provide general recommendations to improve both training and research, while avoiding bottleneck among the scientific workpackages.
Assessment : it is expected that the RTCB will monitor its own activity. Nevertheless, the project co-ordinator will review the RTCB member's commitment and the relevance of their recommendations.

Workpackages:
Composition: each WP will be composed of a Workpackage Leader responsible for the work to be carried out by every workpackage as described in the workplan. Each Workpackage leader is responsible for the co-ordination of the activities carried out by his/her Workpackage. She/he reports to the scientific co-ordinator.
Objectives: The WPs are responsible for the set of activities assigned to them in the work plan, and are in charge of the corresponding reports and deliverables. The WP leaders will be members of the RTCB and are also expected to collaborate and exchange views with the other scientific workpackages for an improved co-ordination among the network's activities.
Tasks: each WP is composed of several sub tasks that have to be conducted, as described in

the workplan.
Means: the activities carried out in the different WP will rely on both the students and on the expertise provided by the NUMAS partner institutes to fulfil their objectives.

Assessment : The **workpackage leaders** will perform a regular follow-up of their WP activities. The **RTCB** will be perform a general assessment of the WP activity.

SCIENTIFIC CO-ORDINATOR

Dr Mario Arioli will be performing the **scientific co-ordination** of the network. He will be carrying this role chairing the RTCB, and in collaboration with high profile experts among which Prof. Erricos Kontoghiorghes, Prof. Bernard Philippe, who are the two chairs of the second ERCIM Working Group "Matrix Computations and Statistics", Prof. Franco Brezzi (director of the IMATI-CNR) as expert for the fields of partial differential equations and their applications, and Prof. Philippe Toint (University of Namur) as expert in the field of Optimization.

PROJECT CO-ORDINATOR

While the scientific coordinator Dr Arioli will be focusing on the scientific coordination, the **project coordinator**, **Bruno Le Dantec**, will be assisted by the ERCIM Office team (4 dedicated staff) to concentrate its activities on the overall management and administrative and financial co-ordination of NUMAS.

This will imply directing the administrative work of the network, managing the Human Resources, the Mobility Program requirements and ensuring institutional exchanges with the European Commission representatives. The co-ordinator is also responsible for managing the progress and management reports, monitoring the project costs and signing the agreements with the selected researchers. The ERCIM Office team, will assist him in his day-to-day management such as the call preparation for recruiting early-stage or experienced researchers, to monitor the network's events or the dissemination activities. The ERCIM Office will also ensure that a constant contact will be maintained with the selected researchers.

ERCIM Office team which has a proven **expertise in managing networks**. The FP5 RESET network on smart card involved 120 members managed by ERCIM and within FP6 ERCIM will be managing two networks of Excellence, namely MUSCLE and DELOS. Within NUMAS, ERCIM will perform a financial interface between the European commission and the NUMAS partners, redistributing funding efficiently to avoid otherwise lengthy and costly procedures.
The **selection procedure** will be the following. The NUMAS contact point in ERCIM Office will receive the students application. The Office will interact with the student requesting the appropriate documents to ensure a thorough evaluation. All these information will be made available on the NUMAS Web site for the consortium to consult. Every application will be reviewed by one or more senior scientist in each partner institute. The RTCB then decides on the final recruitment taking into account:

- The qualification of the applicant,
- The overlap of interest between the applicant and the hosting institutes,
- The available funding

All partners are well aware of the necessity to **promote gender parity** during the recruitment procedure. It will be clearly indicated in the advertisement that the consortium decides to ensure the participation of at least one third of each gender in the project, and evaluators will be briefed before any evaluation of the candidates.

Beyond the administrative and financial co-ordination, ERCIM will also have to provide the best environment for both research and training within NUMAS. This will call for providing the network with reliable working tools and a collaborative environment. The underlying idea is to eliminate any potential communication bottleneck and to stimulate exchanges not only among partners, but also and above all among students.

Finally, being also responsible for the dissemination activities within NUMAS, ERCIM will also:

- Organise workshops to present the achievements of the network
- Publish papers at conferences and in journals;
- Support the mobility of early-stage and experienced researchers among the network participants;
- Perform broad dissemination in the European Scientific Community;
- Establish and update a dedicated web site to give information on the project to visitors,
- Attend International conference
- Include articles in ERCIM News, distributed at more than 11000 copies world-wide.
- Prepare an electronic Newsletter dedicated to the network.

B4.2. Management know-how and experience of network co-ordinator

The NUMAS Research Training Network will be co-ordinated and managed by EEIG-ERCIM, the European Research Consortium for Informatics and Mathematics. ERCIM is an organisation dedicated to the advancement of European research and development in information technology and applied mathematics. Its seventeen national member institutions aim to foster collaborative work within the European research community and to increase co-operation with European industry. As such is has a long an proven expertise as a project co-ordinator and as a training institution for PhD students in different institutes disseminated across Europe.

ERCIM has a long experience in managing EC projects. The central office of ERCIM, located in France, is a small and flexible administrative unit, which acts as a front-end to access the scientific expertise of its members. Since 1990, ERCIM has been involved in over 30 European projects under the ESPRIT, IST FP5, Telematic, INCO-DC, IST, HCM and TMR Programmes. In these projects, the ERCIM office takes care of the financial and administrative tasks. This distribution of work has been a valuable asset, allowing the research institutes and the other partners to focus on the scientific tasks at the core of the project. Within FP6, ERCIM has already been praised for the excellence of its management and will be co-ordinating two Networks of Excellence in Europe, MUSCLE (Semantic web) and DELOS (Digital Libraries).

In managing training and educational initiatives, the ERCIM Human Resources Management will be a valuable asset. Indeed, ERCIM has also a great experience in the Human Resources and Mobility management through different activities such as the internal mobility scheme, the Fellowship Programme, and the PhD mobility Programme .

The Internal Mobility acts as an important tool to bring closer the scientists working in different institutes and this way to improve the corporate feeling in this virtual organisation. The main assets of ERCIM are the human potential (in number and quality) affiliated in the member institutes and the portfolio of the R&D topics offered to the outside word. The efficient use of this huge potential is unimaginable without the cross-fertilisation of the ideas and projects, where the personal contact may act as a key factor.
ERCIM uses its Internal Mobility to contribute to strengthening ERCIM potential in

- providing expertise and potential in a broad field of computer science, information technology and applied mathematics, by using the complementary nature of the member institutes,
- reacting to new challenges quickly,
- providing a versatile education scheme for young researchers, etc.

The Internal Mobility constitutes only one element of a set of related programmes, activities within ERCIM, e.g. Working Groups, post doctoral Fellowship Programme, Vital Statistics, Entrepreneurial Fellowship, Familiarisation Days, etc.

The ERCIM Fellowship Programme was launched in 1990 to enable young scientists to perform research at different ERCIM institutes disseminated across Europe. The fellowships are available for PhD holders from all over the world. The objective of this Programme is to enable bright young scientists to work collectively on a challenging problem as fellows of leading European research centres. An ERCIM fellowship helps widen and intensify the network of personal relations and understanding among scientists. To promote cross-fertilisation and co-operation between research groups working in similar areas in different laboratories, the fellow is hosted by two ERCIM Members for a nine-month period each. With twelve years of previous experience, more than 100 fellows were awarded through this ERCIM Fellowship Programme. The ERCIM working groups also actively contributes to identify the research topics to be included in the half-year calls published for the ERCIM Fellowship Programme.

The PhD Mobility Programme is a new scheme organised to fund PhD supervisors at two ERCIM institutes to arrange for their students to spend part of their study time at another ERCIM Institute. The programme provides a structure for ERCIM supervisors to identify researchers in other ERCIM institutions to collaborate in the joint supervision. It also provides funds to cover the travel costs associated with this collaboration.

To conclude, the co-ordinator is not only a breeding ground to attract the best young and experienced researchers in this field via his current activity and his network of centres of excellence, but is also able to bring its experience to manage at international level this Research Training Network.

B4.3 Management Know-How of the Network Teams

Team 2 CCLRC-RAL CSD Numerical Analysis Group

The Numerical Analysis Group is part of the Computational Science and Engineering Department of CCLRC-RAL. The CSE Department is in charge of the High Performance Computing activity and run the HPCx system based on IBM's p690 high-end compute nodes (1280 nodes) with a peak performance of 6.6 TeraFlop/s (3.5 Tera Flop/s sustained). In addition, group members have been heavily involved in the Institute of Mathematics and its Applications, the IMA Journal of Numerical Analysis, the Mathematics College of EPSRC, the organization of national and international conferences, refereeing and editing, seminars and teaching at universities and summer schools, supervision and examination of research students, writing books and papers, developing mathematical software, and advising UK and overseas governments on high performance computing. The group members actively collaborate with several of the teams involved in the project: University of Namur, IMATI-CNR, CERFACS, IRIT-INPT, University of Basel, University of Strathclyde, and the institute of Computer Science of the Academy of Sciences of the Czech Republic.

Team 3 contribution Institute for Scientific Computing, University of Salzburg

The team from the university in Salzburg can participate at the network organization and management in the following items:

- theoretical and methodological training of the early-stage researchers in the areas of parallel signal processing, data retrieval and parallel linear algebra
- we will provide a newly installed high-performance computer cluster to the research teams participating in the network
- according to our coordinating experience (e.g. a long-term international project Parallel Numerics) we can coordinate the work on the development and application of the SVD methods and data compression of partners who will be involved at work on these and related topics
- we can organize network workshops which will serve to a better coordinantion of the network in specific areas
- according to the membership of Prof. Vajtersic and Prof. Uhl in the editorial boards of international journals, special issues can be published in order to disseminate the results obtained in the network.

Team 4 Katholieke Universiteit Leuven (KUL-SISTA and CS-NA/AM)

The Katholieke Universiteit Leuven consists of the following two groups: KUL-SISTA and CS-NA/AM. The Group KUL-SISTA has significant research experience and experience of organizing and collaborating research.

Involvement in other EU projects: Partner of the European thematic Numerics in Control network programme in the field of Industrial and Applied Technologies, entitled NICONET (contract number: BRRT-CT97-5040) where Sabine Van Huffel is the main coordinator. This project started on January 1, 1998, and ended on June 30, 2002. In addition, SCD/SISTA

participated in 6 other terminated fp5 projects and is partner of 4 ongoing projects (fp6 EU integrated project ETUMOUR , fp6 network-of-excellence BIOPATTERN, fp5 EC shared-cost RTD project PDT-COIL , fp5 project CAGE).
In addition, the KUL-SISTA members have a large number of current national, interuniversity and intrauniversity research grants, and have held several KULeuven and EU Visiting Fellowships to support visits by foreign researchers for periods of 3 months to 1 year.
KUL-SISTA has organized several conferences in Leuven, including the Int. Workshop on TLS (1991, 1996, 2001), ESANN 1996, European Control Conference (1997), IEEE Benelux Signal Processing Symp.(1998), Int. Workshop on Black Box Modelling (1998), Parallel Applications in Statistics and Economics (PASE 2000), ISCAS 2000, IACR Eurocrypt (2000), Benelux Meeting on Systems and Control (2001), NATO ASI on Learning Theory (2002), Belgian Bioinformatics Conference 2003.

The CS-NA/AM group has already experience managing an international network. CS-NA/AM was the coordinating group of a European Union, Human Capital and Mobility network: "ROLLS: Rational Approximation, Orthogonal Functions, Linear Algebra, Linear Systems, Signal Processing" (1-12-1993 to 31-11-1996). This network consisted of 8 research teams from 7 countries.
On a national scale, CS-NA/AM coordinates a Scientific Research Network of the Fund for Scientific Research (Flanders) "Advanced Numerical Methods for Mathematical Modelling" which consists of 12 research groups active in the field of numerical analysis and the application of numerical methods: 7 Flemish research groups, 2 groups from other Belgian universities, and 4 groups from abroad.
CS-NA/AM is also the editor of the Scientific Computing and Mathematical Engineering (SCME) Digest which is a Belgian regional mailing list announcing seminars and conferences related to applied mathematics and scientific computing.

Team 5 Numerical Analysis Department of Mathematics at the University of Namur (FUNDP)
The FUNDP team has experience in managing multi-institution collaborative research projects. In the last 5 years it has been involved in such projects for the EU, the Belgian national board of Science and Technology Research (SSTC), the national "excellency poles", NATO and regional projects. The team enjoys a dedicated half-time secretarial support in addition to the departmental services. The financial matters and human resources management are reviewed within the team but managed by the professional university accountancy department.

Team 6 Institute of Computer Science, Academy of Sciences of the Czech Republic

The department runs regular Computational Mathematics Seminar (founded in 1992), organizes international conferences, e.g. Computational Linear Algebra with Applications (MILOVY 2002) and Modeling: a series of IMACS conferences on Mathematical Modeling and Computational Methods in Mechanics, Physics and Geodynamics. Its members cooperate with several universities and research institutions in CR (TU Liberec, MFF UK Prague, FJFI CVUT Prague) and have extensive contacts with universities and research labs practically with all research teams within and also outside the network of the current proposal (Emory University, Atlanta, Los Alamos National Laboratory, respectively).

Team 7 The Royal Veterinary and Agricultural University (RVA) Department of Dairy and Food Science **Food Technology Section – Chemometrics Division**

Since it initiation in 1991 the Food Technology Section at RVA has 5 permanent staff and appr. 20 temporary staff members (assistant professors, post-docs and PhD candidates). The group functions independent within the Department of Dairy and Food Science.
The group contributes both at participation and management level in numerous national and international research initiatives. These programs form the main source of income for the research conducted in the group. A few of the past and present large-scale/multiple participants programs are: AQM (Advanced Quality Monitoring in the food production chain; Danish governmental funding), VICIM (Virtual Institute for Chemometrics and Industrial Metrology; European funding), FSK03-3 (Characterization of techonological and sensory quality in food by NMR/MRI; Danish governmental funding) and ODIN (Danish industrial funded consortium run by the group).
Over the past 10 years the group has collaborated with more than 50 industries and universities world-wide and has a high fraction of foreign researchers in the group through research-funded projects and also as part of a Major Research Infrastructure (MRI). Five members of the group are or have been involved in several major EU projects over the years
Next to a scientific contribution to numerous conferences the group has recently hosted two large international scientific meetings: TRICAP 2000 (ThRee-way methods In Chemistry And Psychology) and SSC7 (7^{th} Scandinavian Symposium on Chemometrics; 2001).
In the International Advisory Board evaluations of the center in which the group is part, the group has continuously been highlighted as one of the most well-known and influential groups within the center as well as within the chemometric community.

Team 8 INRIA/IRISA

INRIA, and locally IRISA, has an efficient administrative organization capable of efficiently managing national and European contracts. During the Fifth Framework Programme, more than 90 projects involved INRIA teams, under the chapter IST.
The Aladin team will be involved in the programme at two levels :
- At the lowest level, the four involved researchers will participate on the activities as indicated in Table B1.5.1. They will cooperate with the experienced researchers and advise the young scientists who will be integrated in the team during the NUMAS actvity.
- At a higher level, Erricos Kontoghiorghes and Bernard Philippe, who are coordinators of the ERCIM Working Group Matrix Computations and Statistics, will use this existing network to organize general workshops (as already done) twice a year and publicise the research activity of the proposed RTN.

Team 9 CERFACS
Advanced Training is part of CERFACS' mission. The team runs a training course for new recruits at CERFACS to give them a basic understanding of high-performance computing and numerical libraries. Training of PhD's is part one of the main tasks of the team. The team is also involved in training of undergraduate student through the French “stagiaire” system.
CERFACS is visited by many distinguished scientists from Europe and the United States, which is a source of inspiration for both the young researchers and the more experienced members of the team..
The CERFACS team has co-organised a large number of workshops and conferences. An overview can be found at http://www.cerfacs.fr/algor/PastWorkshops/index.html. The

team has extensive experience in participating in EC-funded research projects. See http://www.cerfacs.fr/algor/Projects/index.html.

Team 10 ENSEEIHT-IRIT

The ENSEEIHT-IRIT Team has been involved in several national and international projects with multiple partners, either acting as a simple partner or as coordinator of the projects.
We give some significant examples:
1996-1999 : PARASOL project (EU ESPRIT IV LTR project 20160) entitled "An integrated Environment for Parallel Sparse Matrix Solvers". The PARASOL consortium involved reseach labs (CERFACS, ENSEEIHT-IRIT, GMD-SCAI, ONERA, RAL) and industrial partners (Apex tech., Det Norske Veritas, INPRO, MSC Software, Polyflow)
2001-2003: Project funded by INRIA and NSF entitled "Préconditionnements robustes et parallèles: un moyen pour combiner méthodes directes et itératives de résolution de sytèmes"'. French partners: IFREMER, INRIA (Rennes and Rhone-Alpes), and LaBRI. US partners: University of Minnesota, University of Indiana and Lawrence Berkeley Laboratory.
2003-2006 : GRID-TLSE project funded by the french ministery of education. ENSEEIHT-IRIT is the coordinator. French academic partners: CERFACS, ENSEEIHT-IRIT, LaBRI, and LIP-ENSL. Industrial partners: CEA, CNES, EADS, EDF, IFP.
The ENSEEIHT-IRIT Team has also acquired experience in the organization of international scientific events (EUROPAR'99 (1999), Sparse Days and Grid Computing at St Girons (2003).

Team 11 Department of Econometrics, University of Erfurt

The University of Erfurt provides an efficient adiminstrative organization for handling all type of funded reserach activities. The team has experience in acting as a partner or as coordinator of international projects. Furthermore, the team is involved in training at different levels both at the university and outside. Members of the team have co-organised workshops and acted on the committee of international conferences. Thus, it might contribute to workshops and tutorials on the application of optimization heuristics in different fields of statistics, econometrics and quantitative finance. In addition, the team has experience in editing special issues and other collected works.

Team 12 University of Dortmund

Stefan Turek and his collaborator, Dipl. Ing. Frank Platte, have sufficient experience with numerous national research projects and with the collaboration with external partners. Frank Platte will be responsible for the (local) organisation management and will assist in the management of the network.

Team 13 University of Patras, Dept. Computer Engineering & Informatics (High Performance Information Systems Laboratory)

The *Department of Computer Engineering and Informatics* of the University of Patras was the first Department in Greece to offer an Engineering Diploma in the area of Computer Engineering and Computer Science. It has traditionally attracted some of the highest ranking graduates from secondary education and has also maintained an active graduate program that

has an enrollment of around 400 students. These, together with a high quality faculty of around 25 covering most major areas of computer science and engineering with extensive experience at some of the top universities in Europe, the U.S.A. and Canada make the Department a dynamic research community. The Department can boast an important Alumni community whose members now conduct successful careers in industry, government, and academic and research institutions worldwide. The Department participates in EACTS. In collaboration with the nearby Computer Technology Institute (CTI), the Department hosts a regular seminar series for advanced undergraduates, postgraduates and postdoctoral researchers. The University library subscribes to a large number of scientific periodicals in the areas of Informatics and Computer Engineering. An interdisciplinary M.Sc. level programme in "Mathematics of Computers and Decision Making" is run in collaboration with the Mathematics Department offering graduate level courses in Numerical Linear Algebra, Scientific Computing, Deciion Theory, Machine Learning, Neural networks and related areas. There are active collaborations with other Departments within the University of Patras, including the Department of Electrical Engineering, the Mathematics Department, the Department of Physics and the Medical School. More information can be found at the University, Department and Laboratory websites (www.hpclab.ceid.upatras.gr).

Team 14 IMATI-CNR

The Institute takes part intensively in International Research Projects, as main contractor or as partner. Among the projects carried out by the institute it is worth remembering the FIORES project dedicated to both Reverse Engineering and Engineering Design; the M-AQUA project concerned with the use of multimedia in training programmes and long distance training; the projects of "Research Training Network", Breaking Complexity, HYKE and Smart Systems, dedicated to the development of models and techniques which allow for complex applicative problems to be dealt with; the ARION project aimed at developing methodologies for Digital scientific library access; the INVISIP project for the predisposition of a technical platform giving access to data for urban planning processes; the thematic network PRO-EBNIS dedicated to promoting statistics in industry and businnes; TED project concerned with the development of decision support systems for electronic democracy.
Furthermore, the institute has also taken part in various strategic CNR projects and activities financed in the Agency 2000 (Agenzia 2000) environment, as well as activities connected with government funds and agreements, like for instance, the project on the definition of priorities in the interventions made to reduce the risk of earthquakes.

Team 15 IAC-CNR, Bari

The Istituto per le Applicazioni del Calcolo "M. Picone", Consiglio Nazionale Delle Ricerche, sez. Bari (IAC-CNR, Bari) has significant research experience and experience of organizing and collaborating research.
The IAC-CNR, Bari have held some NATO-CNR Visiting Fellowships to support visits by foreign researchers for periods of 2 and 6 months. Every year, the IAC-CNR, Bari, organizes an international summer school in Numerical Linear Algebra and its Applications in Monopoli (Bari).
The IAC-CNR, Bari, has organized some international workshops, including

- Workshop on Structural Dynamical Systems in Linear Algebra and Control: Computational Aspects}, July 2001,
- Workshop on Numerical Linear Algebra and Its Applications}, September 2003,
- Fourth workshop of the ERCIM Working Group on MATRIX COMPUTATIONS AND STATISTICS}, September 2003.

Team 16 Universitá di Roma "La Sapienza"

We have have been responsible for numerous Diploma (Masters) and PhD theses.
We serve as a referee for several first-rate journals and we are on the editorial board of ETNA.

Team 17 Centre de Recherche Public Henri Tudor -(L)
The Henri Tudor research centre has significant experience in European research projects, international research collaborations and experience in oganizing conferences, and foolowships. Members of the team have organised workshops and acted on the committee of international conferences. The Henri Tudor research centre have held some Visiting Fellowships to support visits by foreign researchers for periods of 2 and 6 months.

H. Tudor has recently been participating in the following European projects: Improved Control of Electric Arc Furnace Operations by Process Modelling , **ECSC 7210-PR-129 (1999-2003)**, Nouvelle utilisation intégrée de logiciels de simulation et de contrôle pour une gestion économique et performante de Stations d'Epuration des Eaux, **LIFE98 ENV/L/000582 (1998-2002)**. Centre de Recherche Public is participating, among others, in the following European projects: Creation of a European Network of Contact Points for the Promotion of Innovation around Industrial Property, **LIIP/IPS-2001-40007**, Application Intelligente de Télé-Formation en Management de Projet**, ITEMA, Pr. Léonardo. L/01/B/PP-122000.**
The Business and Innovation Centre 'Technoport Schlassgoart' is an affiliate member of IASP (International Association of Science Parks) and of ESINET (European Space Incubator Network) whose function is to bring aerospace industries and high-tech start-ups closer together.

Team 18 University of Bergen (UiB)}

Staff at Parallab has significant research experience in organizing and collaborating research in an international setting.
Bjørstad has been Principal Investigator in various European ESPRIT projects in the 3rd, 4th, and 5th Framework (including FRONTIER, SISCI, EUROGRID, and ENACTS).
Staff of Parallab holds various national grants for research and development, some held jointly with colleagues at other institutions. These include grants for research and development on scalable (parallel) algorithms for large sparse linear systems, code parallelizations within geophysics and neuro-informatics, and research in scalable algorithms for molecular dynamics.
Parallab has organized several conferences, including
PARA 2000, 3-day Nordic Workshop on Applied Parallel Computing, June, 2000,
ARCADE 2000, 2-day conference November, 2000. ARCADE is Academic Research Computing Advanced facilities Discussion group Europe. It is an annual meeting for Directors of Supercomputer Centers and Research Institutes, which use HPC in their work. It is open by invitation only,
NOTUR2002, 2-day conference on High-performance Computing, April 2002.

Team 19 Institute of Mathematics, Dept. of Informatics, Slovak Academy of Sciences

The research team in Bratislava can assist with the organisation and management of the network in the following areas:

- Participation in organizing the working meetings (possibly also in Bratislava) of the Marie Curie RTN.
- Participation in organizing the workshops/conferences in the field of the efficient parallel linear algebra algorithms with the emphasis on the EVD/SVD of large matrices and applications in signal processing.
- Participation in training of young scientists in the field of EVD/SVD computations. Training can include both serial methods (developed, implemented and demonstrated in MATLAB), as well as parallel methods (implemented on parallel computational facilities in cooperation with the Salzburg University, Salzburg, Austria, and the University of Bergen, Bergen, Norway).

Team 20 Linköping University

The senior researchers of the Linköping group have a wide experience in managing scientific work (department head, director of studies, director of national supercomputer center, editor for scientific journals, organizer of conference etc.). They regularly give courses at the graduate level at European universities and institutes (recently in Italy and Czech republic). The Linköping group can participate in the organization of conferences and Summer Schools especially on the interface between numerical linear algebra and statistics.

Team 21 ETH-Zürich

We have conducted numerous Diploma (Masters) and PhD theses. From 1988 to 1995 M. Gutknecht has directed the Interdisciplinary Project Center for Supercomputing at ETH Zurich; from 1996 to 1999 he was the Scientific Director of the Swiss Center for Scientific Computing.
We have co-organized conferences with several hundred participants (Conpar 90/VAPP IV, GAMM 2001) as well as numerous smaller conferences and workshops (including Householder 96).
We have been on the editorial board of several first-rate journals.

Team 22 Department of Computer Science, University of Basel
UNIBAS has intensive and long-term mutual research activities with the ETH Zurich spin-off companies ISE Integrated Systems Engineering and AutoForm Engineering AG. At the moment, UNIBAS is partner of two national research projects and two international industrial cooperations concerning the development and application of numerical methods for TCAD applications. Scientific and technical synergies with these projects will be a real benefit for the RTN. UNIBAS will actively cooperate with other research groups in the area of preconditioned algebraic multilevel methods. UNIBAS will provide the research training network with challenging problems from various industrial application areas from European SME's like ISE AG, AutoForm Engineering AG and the NEC CCLRE Lab.

Team 23 University of Cyprus

The University of Cyprus has a dedicated administration team to manage the national and

international funded projects. The MCS group will coordinate research in the sub-area "Model selection and computation of econometric estimators" and actively be involved in other sub-areas pursuing research in the interface of numerical linear algebra and statistics.
Erricos John Kontoghiorghes will coordinate with Bernard Philippe the activities of the ERCIM Working Group on Matrix Computations and Statistics.

Team 24 University of Cardiff

Cardiff has hosted students before under the European AgentCities.net network of excellence, and has been involved in staff exchanges with other Universities in Europe, the US and Australia. Cardiff University is a publicly funded university with a strong research program in areas related to this network. Cardiff was ranked 7 out of the 106 universities that were assessed as part of the Research Assessment Exercise (RAE) in 2001, and is a member of the Russell Group to top UK research universities. The university has at all levels a strong commitment to supporting IT based research and in particular has invested heavily to provide a high speed, campus wide network to support collaborative computational science across campus. The University has also invested in connecting Cardiff to a high-speed national backbone network (SuperJanet4), and will act as host for a Welsh Gene-Park (to strengthen the science base of the University). The Welsh eScience Centre is a multi-disciplinary centre which is managed by the Department of Computer Science but includes participants from many areas within the University including Earth Sciences, Bio-Sciences and Medicine, Chemistry and Engineering – each exploring the use of workflow in a range of different application domains. It is one of 8 such regional centres in the UK financed by the government to undertake eScience/Grid related research. The Department of Computer Science has 45 members of staff, of which 37 are research active. The department has strong links with industry, and has funded projects with companies such as British Telecom (BT), Silicon Graphics (SGI), British Aerospace (BAE Systems), Hewlett Packard, IBM, Sun Microsystems, and Vodafone. The department has also started exploring better collaboration with Small and Medium Scale Enterprises (SMEs) through a regionally funded CETIC centre in software technology – supporting technology transfer to local industry

Team 25 University of Manchester (UMAN)

The Manchester Centre for Computational Mathematics (MCCM) has significant research experience and experience of organizing and collaborating research.
Higham was an investigator on collaborative grant funded by ESPRIT Basic Research Action Programme, titled "Performance-critical Applications of Parallel Architectures" (APPARC), involving nine European institutions, 1992-1995.
The MCCM members have a number of current research grants, some held jointly with colleagues at other institutions, and have held several EPSRC Visiting Fellowships to support visits by foreign researchers for periods of 3 months to 1 year.
MCCM has organized several conferences in Manchester, including

- Linear Algebra and Its Applications, July 1995,
- Numerical Analysis and Computers--50 Years of Progress, June 1998,
- One Day Meeting on Structured Eigenvalue Problems, November 2002,
- New Frontiers in Computational Mathematics, January 2004.

Team 26 Oxford University

The various members of the Numerical Analysis Group have significant research experience and experience of organizing and collaborating research.
Different members of the Group have collaborative research projects with groups in France, Sweden, Germany, Italy, Spain as well as other in the UK within the European context. There are several current research grants of varying size, those associated with eScience and Life Sciences being the most significant.
The Group has many research visitors with stays varying from a day to a year.
Several conferences have been organized in Oxford by members of the Group, including Foundations of Computational Mathematics, July 1999, and Numerical Methods for Fluid Mechanics, April 2004, which is the 8th in a regular sequence. Additionally many one-day workshops and meeting are held, with roughly 3 or 4 in any one year.

Team 27 University of Strathclyde

The Department of Mathematics at Strathclyde is highly research active and its members have wide experience in terms of coordinating collaborative projects and organizing conferences. All of the key staff listed hold or have held EPSRC grants and have supervised postgraduate students and/or post-doctoral researchers. The department is a member of the European Consortium for Mathematics in Industry (ECMI) and frequently hosts international visitors.
Members of the Numerical Analysis Group have organised several recent conferences, including

- 15th Householder Symposium on Numerical Linear Algebra, June 2002,
- Numerical Methods and Stochastic Simulation Series, 2001/02,
- Computational Modelling in Medicine, September 2003.

B5 Relevance

European mathematical research already enjoys an outstanding profile amongst the international scientific community. In particular, the activities in numerical mathematics and in statistics undertaken within each European country are of the highest quality. Organisations such as ECMI (European Consortium for Mathematics in Industry) and ERCIM contribute to the recognition that Mathematics, as the language of the sciences, plays an important role in technology, finance, biology, and environmental sciences. Nevertheless, in the words of the Exxon R&D president, Edward E. David still "*too few people recognize that the high technology so celebrated today is essentially a mathematical technology*". As result of this situation, the visibility of numerical mathematics and computational statistics is still quite poor among the public. When new scientific discoveries or new technologies hit the front page of the news, the computational mathematics at the core of them is seldom highlighted. The lack of visibility is also quite serious vis-à-vis European industry, which is increasingly becoming dependent on high technology with a growing need for mathematical expertise in both research and development.

The fragmentation of research among the European countries is a matter of fact, and no single European country is likely to have sufficient expertise of mathematical knowledge. The European Union also recognises this need for the exchange of skills and knowledge between member nations, and has strongly supported its COMETT, ERASMUS and HCM programmes. Moreover, co-operation between European Universities, National Laboratories, and institutes directly financed by each country is still sporadic, essentially undertaken at the national levels, or left to the goodwill of the individual mathematicians.

We strongly believe that the best way to build stronger links between European Universities, National Laboratories and Industry is to encourage young scientists to act as intermediaries.

Our ambition is to create an environment where young scientists would be educated and trained using the skill and the experience of the Universities, the equipment and the expertise of the National Laboratories, on topics of interest for the Industrial R&D centres.

B.6 Added value to the community

The NUMAS project has defined among its priority objectives to perform research and advanced training on the multi-disciplinary subject of computational mathematics. The interdisciplinary concept is applicable within a single well established field such as Applied Mathemathics and/or Statistics: the high level of specialization in some sector makes necessary a training project where the experts transfer their knowledge to their colleagues working in diverse fields and to young researchers, all seeking a better inside view and ready to exercise lateral thinking in their main sector of study. This training network plans to harmonise activities in this domains which is up to now highly fragmented in Europe, be it among institutions or countries.
We want to stress the novelty of our proposal that gathers the important components of the High Tech world, universities and national laboratories around numerical mathematics and statistical topics of common interest, and teaching and training programmes. Moreover,by addressing this particular research area , by supporting the emergence new research angles, by defining a generic approach to it, and by strengthening and broadening the required international collaborations for solving it, NUMAS promotes several ERA objectives.
The first one being to solve the **fragmentation of expertise** among the different members sates, since NUMAS will try to harmonise the different research agendas and curriculum in the area within Europe. NUMAS implements the necessary collaborations to reach its ambition through a training and mobility programme of both early-stage and experienced researchers. It thus meets one of the ERA objectives related to '**maximizing human capital'**: **mobility**.
The second ERA objective related to human capital, **equal opportunity**, is taken in consideration by the NUMAS consortium, since the application from students citizens from Candidate and Associated Countries will be helped during the application review process through a positive weight that will be considered to decide between two applicants of same scientific value. The ERA objective of equal opportunity is to be met by the fact that this training network will favour a better gender repartition than the existing one.
Altogether, our goal within NUMAS is to develop a network that in so far possible unites together the best training and research group from in this research area while integrating more industrial partners in the future. The underlying objective is to create an advanced research community on the computational mathematics agenda, and to pursue research through the maintenance of this network by encouraging young and senior researchers to stay in Europe after studying of working elsewhere. We are very hopeful that by opening the network to Doctoral students , we will be able to persuade some of the best students world-wide to do their doctorate in Europe rather than in the US.

NUMAS research objectives fall within one of the seven principal research priorities of FP6, more specifically within the strategic of IST. Inded, NUMAS will come as a direct support to improving competetivieness in a wide array of computer science applications. NUMAS will not only "*reinforce the European excellenc*e" in the field of mathemetics in which it has a long tradition, but will also help "*overcome weaknesses*" in applied mathematics to computer science where for example the US have international recognition. The underlying objective is to ensure the co-evolution of mathematics, technology and applications.

This training network will therefore provide a reliable ground to carry out further research in this IST priority and provide the European research community with a new breed of experts in the field on whom to capitalise for developing and preserving European expertise in the domain. As far as European policies are concerned, the scope of NUMAS is answering to

various policies' expectations:

NUMAS proposes measures to promote a better gender repartition and the involvement of women. The research and training coordination board will ensure that a gender balance composition of the students is stimulated with a one-third rule for appointment. As the effective percentage of women in this domain is around 15%, this measure is rather challenging. NUMAS partners will implement all positive solutions concerning the gender issue during the lifetime of the project.

It can be expected that the NUMAS network will create long-term synergies between the different teams, that come from different scientific domains and research institutes. This domain will certainly carry a growing importance in the future, and the NUMAS proposal constitutes a good pro-active opportunity to establish a pan-European research structure on that topic.

NUMAS will also provide significant added value to the EC policies, in particular through:

- Identification of strong research teams in candidate countries (CC). The dissemination of this information along our European network will increase the attraction of this institute.
- Participation of researchers from CC who will meet European Colleagues will help them to create a network in Europe.
- Participation in the RTN is a possible window to enter in new consortium preparing proposal for the EC thus a better understanding of the European policies.
- Participation in a very specific activity of theses CC researchers will increase their knowledge and could lead to new curricula in their university.

B7 Indicative financial information

The NUMAS financial breakdown among activities and partners has been designed to serve best the overall purpose of the network: Training, for which regular training network allocate about 65 % of their budget . In this respect, within NUMAS, the network's funding share affected to education and training activities represent more than 80%. This will serve to increase the number of students involved within the network while allowing them to play an active role for a longer period. The 21 early stage students will spend 36 months within NUMAS partner institutes while the 6 experienced students wil be involved for a 24 months periods. This will grant them a valid training period to become themselves young yet experienced researchers in the field.

The remaining funding will be used to support the training activities. Indeed, 7% of the budget will be used for the overall administrative and financial project management by ERCIM and also for the internal and external dissemination effort to be carried out.

Onto this, every research and training have been respectively granted 47 Keuro for Experience students and 30550 euro for early stage students. This amount will cover working material, travel to conferences, consumables, books, journal subscriptions, registration and participation to conferences. This sum will also cover participation to attend the different workshops.

Finally, the remaining 200Keuro will be available for the overall network to support the organisation of the various NUMAS event. In particular, most of the remaining funding will be allocated to finance the "common activities" such as workshops and doctorate schools, invitations, and possibly training material and publications.This will also cover the workshops and doctorate schools, including the general organisation costs and invited speakers, meals, renting rooms, ….

Therefore the overall financial repartition can be described as follows:

Indicative financial information on the network project (excluding expenses related to the recruitment of early-stage and experienced researchers)				
Network Team No.	Contribution to the research/ training / transfer of knowledge expenses (Euro)		Management activities (including audit certification) (Euro)	Other types of expenses / specific conditions (Euro)
	(A)	(B)	(C)	(D)
1.		50000	271 674.46	
2.	8750			
3.	7650			
4.	7650			
5.	7650			
6.	7650			
7.	7650			
8.	7650			
9.	7650			
10.	7650			
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27.	7650			
Totals	200 000	50 000	271 674.46	0

Informative Training Breakdown

	Team		Country	N. Month	Annual allowances	Total costs
Experienced	CCLRC-RAL	2	UK	24	47,000	141950
Early Stage	Univ. Salzburg	3	Austria	36	30,550	134936
Early Stage	KU Leuven	4	Belgium	72	30,550	261100
Early Stage	Univ. Namur	5	Belgium	36	30,550	130550
Experienced	ICS-AS CR	6	Czech Rep.	24	47,000	118744
Early Stage	RVA	7	Denmark	36	30,550	162458
Experienced	INRIA/IRISA	8	France	24	47,000	133120
Experienced	CERFACS	9	France	24	47,000	133120
Early Stage	INPT/IRIT	10	France	36	30,550	135704
Early Stage	Univ. Erfurt	11	Germany	36	30,550	134717
Early Stage	Univ. Dortmund	12	Germany	36	30,550	134717
Early Stage	Univ. Patras	13	Greece	36	30,550	116953
Experienced	IMATI-CNR	14	Italy	24	47,000	127008
Experienced	IAC-CNR	15	Italy	24	47,000	127008
Early Stage	Univ. Roma	16	Italy	36	30,550	129782
Early Stage	Henri Tudor	17	Luxembourg	36	30,550	130550
Early Stage	Univ. Bergen	18	Norway	36	30,550	168050
Early Stage	Linköping Univ.	19	Sweden	36	30,550	142283

Early Stage	SAS	20	Slovakia	36	30,550	96339 157743
Early Stage	ETH Zurich	21	Switzerland	36	30,550	157743
Early Stage	Univ. Basel	22	Switzerland	36	30,550	125177
Early Stage	Univ. Cyprus	23	Cyprus	36	30,550	144256
Early Stage	Univ. Cardiff	24	UK	36	30,550	144256
Early Stage	Univ. Manchester	25	UK	36	30,550	144256
Early Stage	Oxford Univ.	26	UK	36	30,550	144256
Early Stage	Univ. Strathclyde	27	UK	36	30,550	
						3676778
	Totals			**900**		
BUDGET						3676778
Fellows (at least 65% of the budget)			**81%**			
Other costs						250000
Sub-total						3926778
Management expenses						274874.46
Overhead						420165.246
Total						**4 621817.706**

ENDPAGE

HUMAN RESOURCES AND MOBILITY (HRM)
ACTIVITY

MARIE CURIE ACTIONS
Research Training Networks (RTNs)

PART B

"NUMAS"