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WGS Newsletter

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1 Editorial

This is WGS newsletter 11, entirely devoted to the results of our NICONET questionnaire distributed in October 1996. This questionnaire was sent out to 285 people, 72 of which replied. We would like to thank all repliers for their efforts, especially those who commented our questions extensively and provided us new ideas and interesting suggestions. The results of this questionnaire are summarized in this newsletter. More detailed results, including all comments raised by the repliers, are described in WGS report 97-1[1]. These results are very encouraging for us, since they clearly show that the control community has a high interest in all proposed NICONET activities.

At present we are selecting new partners from universities, research centers, as well as from industry, who expressed their strong interest in contributing actively to the network. Selectivity is based on complimentarity with the experience of the present NICONET partners (of the exploratory phase) and according to the specified needs. This extended group of at least 10 partners, of which at least one third should come from industry, needs to submit a new proposal to the EC for the implementation of the network NICONET before the end of April 1997. More details on this proposal, as well as the complete list of partners, will be given in the next WGS newsletter. In addition, WGS newsletter 12 will include more details on our ongoing SLICOT activities. In particular, Vasile Sima, actually visiting the ESAT Laboratory for a period of 6 months (October 96 – March 97), is working hard to upgrade and improve wherever possible all routines of the second release of the SLICOT library before making them freely available via ftp.

Sabine Van Huffel
Chairperson of WGS and Coordinator of NICONET.

[1] This report is available through World Wide Web (URL http://www.win.tue.nl/wgs/) or via anonymous ftp (wgs.esat.kuleuven.ac.be/pub/WGS/REPORTS/rep97-1.ps.Z).

2 Introduction to the NICONET Questionnaire

The Commission of the European Communities has given an exploratory award to WGS[2] in order to set up a thematic Numerics in Control network in the field of Industrial and Applied Technologies, entitled NICONET (contract number: BRRT-CT96-0038). The aim is to formalise and extend our current collaboration into a European network to coordinate the development of robust numerical software for control systems analysis and design. Such software is an essential ingredient in modern computer aided control system design (CACSD) and thus for the future of high-tech European industry in a wide variety of applications. This network enables WGS to extend its activities in the area of numerical methods and software for control to a European level and to act as an information center. The intended benefits of NICONET include:

- The establishment of industrial links to ensure that industrial requirements are being met, and to keep industry informed about developments and availability of software;
- The establishment of an information centre on numerics in control software for industry, researchers and software developers;
- The establishment of electronic mail reflectors, world wide web pages, electronic repositories and an electronic journal to allow ready information exchange, up to date sources of information and software, and a means to publish and make available important software and results;
- The coordination of the development of software, including test software, benchmark problems and industrially relevant examples.

The partners of NICONET are:

1. **KUL-SISTA** Katholieke Universiteit Leuven, Department of Electrical Engineering, Research Group SISTA, Leuven, Belgium.
   Contact and Coordinator: Prof. Sabine Van Huffel
2. **UCL-CESAME** Université Catholique de Louvain, Centre for Systems Engineering and Applied Mechanics, Louvain-la-Neuve, Belgium.
   Contact : Prof. Paul Van Dooren
3. **TU Eindhoven** Eindhoven University of Technology, Eindhoven, The Netherlands :
   (a) Department of Mathematics and Computing Science.
   Contact : Drs. Aloys Geurts, Mr. Ruth Kool
   (b) Department of Electrical Engineering.
   Contact : Dr. Ad van den Boom
4. **TU Delft** Delft University of Technology, Delft, The Netherlands, Department of Electrical Engineering, Systems and Control Engineering Group.
   Contact : Dr. Michel Verhaegen
5. **DLR** Deutsche Forschungsanstalt für Luft- und Raumfahrt e.V. Oberpfaffenhofen, Germany.
   Contact : Dr. Andras Varga

[2]For more information, see the WGS web site http://www.win.tue.nl/wgs/wgs.html

6. **NAG** The Numerical Algorithms Group Ltd, Oxford, United Kingdom.
   Contact : Mr. Sven Hammarling

7. **TU CZ** Technical University Chemnitz-Zwickau, Numerical Analysis Group, Chemnitz, Germany.
   Contact : Prof. Volker Mehrmann

They have a proven record of collaboration on the development of reliable and robust software, expertise in the many aspects of numerics in control and control applications, and have a number of existing links with industrial users. NICONET will enable this collaboration to continue and to expand in order to make the much needed software available to European industry in a timely fashion. A major outcome from NICONET will be the production of a library for numerics in control (called SLICOT) which is mature with respect to size, completeness and quality. This library will be developed on modern computing platforms and made available through the information centre.

In order to evaluate the proposed network, WGS has set up a questionnaire[3] for obtaining:

- an inventory of existing research activities in the area of control software;
- a list of potential partners ready to contribute actively to the collaborative effort and NICONET aims,
- an assessment of the relevance of the NICONET objectives and network activities.

This report presents the results of this questionnaire, which consists of the following 3 parts:
1. General questions,
2. NICONET objectives and network activities,
3. Inventory and evaluation of Control software.

The NICONET questionnaire was sent out by ordinary mail on October 15 and 16, 1996, to 285 people, selected from:

1. the WGS address list (only addresses within Europe),
2. the KUL-SISTA address list of contact persons within Europe,
3. the list of industrial partners attending the European Conference on Control (ECC),
4. addresses of a related EC project coordinated by Prof. Ackerman and provided by Dr. Andras Varga,
5. the NICONET proposal (all partners and potential new academic and industrial partners mentioned in the proposal).

In addition, the questionnaire was announced via the WGS and NICONET home pages and also via an announcement in the November issue of the E-LETTER on Systems, Control, and Signal Processing (editors: Anton Stoorvogel and Siep Weiland from Eindhoven University of Technology). Interested persons had the possibility to retrieve the questionnaire either by

[3] available by anonymous ftp at wgs.esat.kuleuven.ac.be in the directory pub/WGS/NEWSLETTER

anonymous ftp[4] and then send their answers via e-mail to the coordinator, or to fill in the questionnaire directly via World Wide Web (WWW)[5] which was then sent automatically to the coordinator.

We received 72 answers back, 7 of which were sent via e-mail (through the use of ftp) and 17 via WWW. So, most answers reached us via ordinary mail. The answers to all questions are summarized in the next sections.

[4] at wgs.esat.kuleuven.ac.be in the directory pub/WGS/NEWSLETTER
[5] http://www.win.tue.nl/wgs/niconet.html

3 Answers to General Questions

1. **Identity, Affiliation, Country**
   The results of this questionnaire are based on 55 answers from people working at Universities or research institutes and 17 answers from people working in industry. They came from the following countries: Belgium (7 persons), Bulgaria (2 persons), Canada (1 person), England (9 persons), Finland (1 person), France (4 persons), Germany (17 persons), Greece (1 person), Hungary (1 person), Italy (2 persons), Poland (1 person), Portugal (3 persons), Romania (3 persons), Slovakia (1 person), Spain (6 persons), Sweden (3 persons), Switzerland (1 person), and The Netherlands (9 persons).

2. **Access to Internet**
   70 persons have an e-mail address, while 27 persons also gave their URL address.

3. **Computer type and operating system used**
   The following computers and operating systems are used (between brackets you can find the number of people using the corresponding computer or operating system).

Type:	workstation (47)	Operating system:	Unix (46)
	PC (59)		Windows 95 (36)
	supercomputer (4)		Windows NT (16)

   It should be noted that 33 people use both workstation and PC. Furthermore, 2 persons use a VAX as computer. Other operating systems in use are: Mac OS (3), Windows 3.11 (5), Windows 3.1 (7), Parix (1), Finder (1), DOS (4), OS/2 (1), Linux (1), VMS (3), and MVS (1).

4. **Standard mathematical software used**
   The following software is used (between brackets you can find the number of people using the corresponding software).

EISPACK (19)	IMSL(10)	LAPACK (22)	LINPACK (21)
Maple (23)	Mathematica (19)	Matlab (71)	NAG (15)
Numerical Recipes (8)			

   Furthermore the following packages are also used: SIMULINK (2), HARWELL (2), MUPAD (2), PVM (1), MPI (1), ScaLAPACK (1), PLAPACK (1), FeH(1), Gregpah (1), ACSL (1), SDIFAST (1), SLATEC 3.1 (1), STARPAC (1), GRAPHER (1), SURFER (1), ODEPACK (1), OPTDES (1), FFSQP (1), DSSI2 (1), DSTOOL (1), LOCBIF (1), Visual Basic (1), OFFICZ (1), and Geometric Bounding Toolbox (1).

Note that all but one replier use Matlab which is mainly due to the user-friendliness of the product.

4 Network Activities: Evaluation, Comments, New Suggestions

A list of 10 proposed network activities to be coordinated through NICONET has been given. Each activity had to be evaluated by giving a number from zero (no interest) to five (high priority). In addition, comments could be added to each proposed activity. Below follows the list of proposed activities. For each activity, the sample mean score is given together with the sample standard deviation (after the $\pm$ sign), as well as a short summary of the given comments.

1. In the past, WGS essentially relied on the expertise and software developed by its own members. Each contributor had its own focus, so that the present library only covers part of the whole field. Therefore the participants list should be expanded and a **European network is ideal** for this purpose.
   Score: 3.76 ± 1.24
   Comments:
   The establishment of a European network for control systems analysis and design software is of primary importance for both the software developers and users. It provides the opportunity to enlarge the areas covered, and to fulfill better the users' requirements. However, quality control on the software made available must be imposed. Therefore, feedback from others than the developers is absolutely necessary. Contributions from outside Europe could be interesting too, but the creation of a European network is certainly a major step. In addition, it is important that the network has a group of members active in software related topics, in order to have some efficiency.

2. The main aim of WGS is to see the library be used by as many scientists and engineers in industry as possible, so that the careful efforts of the contributors bear fruit. This requires a wider distribution, and in order to guarantee this, **a better integration of the SLICOT library in a user friendly environment** is needed.
   Score: 4.06 ± 1.19
   Comments:
   Most software users want to have flexible and powerful, but easy-to-use tools. Therefore, an integration of the SLICOT library in a user-friendly environment such as Matlab is a prerequisite for a wide distribution of software. If it is not easy to use it will not be used, certainly not in industry!

3. A first step in this direction could be the **use of a compiler that automatically passes the function parameters** from the CACSD environment, such as MATLAB, to any FORTRAN routine of the SLICOT library and back (e.g. the NAGWARE Gateway Generator, developed by NAG), which clearly makes the routines of a FORTRAN library available to a broader group of users.
   Score: 3.99 ± 1.27
   Comments:
   This is strongly encouraged since most people in control only use Matlab and refuse to use SLICOT because of a lack of user-friendliness. However, the routines in Matlab beyond Eispack/Linpack are often quite bad. Therefore, many people would appreciate it if the routines of SLICOT are available in a package like Matlab. A single homogeneous user-interface is of high importance: often people are willing to sacrifice speed for

ease of use. However, people do want reliable answers, and therefore reliable software is needed. In addition, the availability of SLICOT in other common packages and on different platforms would be very much appreciated.

4. **Software engineering aspects** have to be further elaborated and **tested in the context of a practical industrial application**. This should allow us to evaluate and benchmark the SLICOT library on end-user problems and will be a more realistic validation of the user-friendliness of the product.
   Score: 3.85 ± 1.23
   Comments:
   The real-world applications are the ultimate means for validating any theory, design, or software product. Moreover, these applications provide useful suggestions for extending the scope of the SLICOT library, for improving the efficiency, robustness, and usefulness. In industry the SLICOT library is most likely to be used in a research department, not in actual manufacturing.

5. The further evolution of the library should be assessed by real industrial applications with respect to its performance, reliability, versatility and so on. In particular, SLICOT should be turned into an **efficient package for large scale applications**.
   Score: 3.53 ± 1.23
   Comments:
   SLICOT should be at first kept as a subroutine library for standard problems without having large-scale applications in mind. First of all, there will always be the need for the numerical solution of standard problems. Second, not all control problems have also large-scale counterparts. Moreover, large-scale problems are often very different in nature and therefore require different programming models/computer environments. The design of a library for large-scale applications should complement SLICOT, but first there is a need to define the problems where large-scale problems arise. The approach could be similar to the extensions of LAPACK: there is a basic subroutine library, and then there are subroutine libraries for several large-scale applications, e.g., ScaLAPACK, PLAPACK,... In this context high performance computer tools are appropriate (software packages like BLAS, LAPACK and new parallel packages should be used).

6. We will not only implement our software in applications of industrial partners of the network, but also **try out more advanced control strategies** that were developed by academic experts and proven to perform better than the conventional methods.
   Score: 4.08 ± 1.07
   Comments:
   It is of major importance to develop demonstration programs that prove that the academic approach has significant advantages over the approach the engineer uses which may be well-known, robust, used for years, and much easier to understand. The proof should be such that applied engineers having only a basic mathematical/numerical knowledge can easily see that the new approach saves time and money. In addition, cooperation with toolboxes or solution providers (Aspentech, Mathworks) is important.

7. In order to guarantee a proper distribution of the SLICOT library, we are convinced that the product ought to be made **freely available**.
   Score: 4.29 ± 1.36

16 persons are interested in commercial support, 38 are not interested and 18 persons didn't answer this question (some of which found the question too unclear).
Comments:
Free availability is great but a commercial version with support is the best choice for another group of people. Optimally, both should be available. Indeed, there is a difference between academic and industrial users. In academia, one is happy to have freely available software. For industrial users, it can be of major importance that there is an address where they can ask for support/troubleshooting. Often, people trust software only because it is commercial rather than public domain. In addition, this policy allows to use most of the NETLIB programs, e.g. LAPACK, GNU.

8. We want to start an **electronic journal for control and systems software**. The rationale for this is twofold. First, we expect that software submissions to this journal will be valuable additions to the SLICOT library. Secondly, we wish to try to collect evaluations and comparisons of software for systems and control theory.
Score: 3.88 ± 1.28
Comments:
If the review procedure is fast this is a very interesting way to speed up the spread of results (in many journals it takes about 2 or 3 years). However, the number of journals already existing is rather high. In particular, there is a new electronic journal of control that was just started by INRIA. Could this activity be combined with this journal or another journal in control or software? In addition, control benchmarks should be included.

9. The **use of electronic means** is most appropriate in setting up our network: the newsletter (electronic version) and the WWW home page, the software repository of the SLICOT freeware and a new electronic journal will be major assets for the participants of the network to be established.
Score: 3.99 ± 1.35
Comments:
The use of electronic means as described above is clearly most appropriate in setting up the network. These means will also provide the needed communication between the teams working in control system areas, either in academia or industry. However, the care and cost to maintain an electronic system must not be underestimated. In addition, it should be noted that outside of universities the use of electronic means is not standard, or sometimes an expensive standard.

10. **Regional workshops** around the topic of control algorithms and software with emphasis on **industrial applications** will be organised.
Score: 3.67 ± 1.24
Comments:
These workshops could best be organized in connection with existing conferences and should not necessarily be regional. International (European) conferences could also be organized occasionally in order to stimulate exchanges and collaborations. Costs should be kept low. It is expected that these workshops will promote the recent advances in the field of control algorithms and software and will strengthen the relationship between researchers from academia and industry. Of course, industrial participation should be assured. In addition, the organisation of short courses for researchers in industry is

encouraged.

In addition, the following **additional network activities** have been proposed.
NICONET should grow to a network of excellence. However, the above activities are already extensive. Therefore, it is better to concentrate on those before trying to expand further. The transfer of automatic control technology and tools from one region (or country) to another could also be an important topic for the network. In particular, a related objective of the network could be to facilitate the effective cooperation between teams and individuals involved in control systems analysis, design and implementation. Providing some financial support, for instance for participating in regional workshops, could be necessary for some individuals, especially from eastern and central European countries.

Nineteen **people expressed their strong interest** (by means of the highest score 5) **in contributing actively to the network and also specified their possible contribution.** The NICONET kernel is currently selecting the most appropriate partners for the extended network according to the above specified needs.

Finally, we summarize **further remarks and suggestions.** Some people think that the WGS initiative to set up a thematic Numerics in Control network in the field of Industrial and Applied Technologies (NICONET) will have a strong impact on increasing the European industry competitivity. But other people are sceptical of the value of networks, except as a means of bringing together no more than 2 or 3 groups with strong shared interests, and do not see which role SLICOT has to play in developing things not already available in excellent commercial packages.

5 Inventory and Evaluation of Control Software

5.1 Availability of Software

The following control libraries and packages are used (between brackets you can find the number of people using the corresponding software).

Library:	SLICOT (8)	Package:	scilab (2)
	Matlab toolboxes (65)		Matrix-X/Xmath (6)
	RASP (3)		ANDECS (3)

Furthermore, the libraries LISPACK, SYSLAB, 20-SIM and program CC were mentioned once (used by one person), as well as the packages CADACS, CONOISSEUR, SMCA, DMC, and DMC+ . The average number of full-time equivalent persons available for control related software development in the group of the repliers to our questionnaire is 1.73 persons (the standard deviation is 2.24). Observe again the large number of Matlab toolbox users, mainly due to their ease of use.

5.2 Description of Other Research Activities

Other relevant research activities are: the organisation of courses and workshops in the area of control, the publication of research papers and books, the development and extensions of software packages in modelling, systems and control, and the development of a design environment. In addition, several people mention involvement in other European networks, industrial collaboration, and research in related areas such as process simulation and mechatronics.

5.3 Need for new software and RTD topics

Almost all repliers expressed their **needs for new software** (preferably in Fortran 77 or Matlab) and/or **RTD**[6] **topics**. In particular, software is needed for model reduction, periodic systems, robust control design, optimal control, aerospace vehicle design, control system design for linear and nonlinear systems with behavioral approach, applications in mechatronics and sensor array signal processing, large scale control problems and singular control problems, the development of condition and accuracy estimates with quality comparable to LAPACK, the analysis and design of periodic systems (including multi-rate), uncertainty modelling (LFT), H_∞ control and controller reduction, symbolic control systems and LQ H_∞ design, model development in chemical engineering, optimisation of differential-algebraic equation systems (large scale), dynamic simulation, highly stiff systems, variable structure control support, application integrators (modelling to control), nonlinear parameter estimation, solving minimax problems, combined numerical symbolic tasks, the control of discrete event systems (automated approach) and hybrid systems, also system theory and system identification of positive linear systems, simulation, nonlinear identification and control, descriptor systems, and frequency response.

In addition, specification tools and tutorial tools on new methodologies, software tools that increase the efficiency of developing process control applications, user-friendly user-interfaces and interactive software packages, high-performance subroutine libraries, data validation tools, identification tools and simulation of hybrid systems, as well as interfaces to

[6] i.e., Research and Technological Development

CAD tools and connection to a library for convenient storage and retrieval of models is necessary. Other topics of interest are real-time implementations of control software in embedded systems, and implementations of control algorithms with integer-based arithmetic for the development of automotive control systems.

Furthermore, it was **suggested** to discuss the use of other languages such as Fortran 90 or C for software development in the future, as well as the most appropriate tool for multi-language programming.

5.4 Development of control related software

Finally, 31 persons filled in the **appendix describing control related software developed within their group** (university/research institute/industry). Software contributions were reported for the following areas (between brackets you can find the number of contributions reported in that area).

System Identification (13)	Adaptive Control (7)	Time-varying Systems (3)
Optimal Control (9)	Nonlinear Systems (7)	Descriptor Systems (3)
Model Reduction (8)	Periodic Systems (4)	Neural Networks (3)
Time Response (8)	Fuzzy Systems (4)	Deadbeat Control (2)
Frequency Response (8)		

In addition, the following areas were cited: nonlinear optimisation (2), time reduction (2), forecasting (2), SVD (1), bond graphs (1), qualitative model (1), prediction (1), controller synthesis (1), controller reduction (1), eigenvalues for structured problems (1), Lanczos methods for control problems (1), singular values in control problems (1), pole assignment (1), linear least squares (1), time series (1), signal processing (1), systems analysis (1), dynamic optimisation (1), robust control system design (1), and system monitoring and control (1).
Programming languages are Fortran 77 (for 22 contributions), matlab (for 19 contributions), C (for 9 contributions), and C++ (for 7 contributions). In addition, the use of the languages Ansi C, Labwindows, Prolog, flex, PWXPCE, Mathematica and Maple is mentioned for just one contribution.

6 Conclusions

The results of the questionnaire show that the control community has a high interest in all proposed NICONET activities. The expansion of the present WGS network (NICONET partners in the exploratory phase) to a European level is strongly encouraged in order to obtain a wider base of software developers and potential users. The network should focus on the development of numerically reliable and efficient control related software which should be freely available and embedded in a user-friendly environment such as Matlab in order to guarantee its widespread use in both academia and industry. In addition, the library should be benchmarked and validated by means of real industrial examples. Commercial support should be provided too, especially for industry. Finally, the use of electronic means is the most flexible and user-friendly way to enhance information exchange and collaboration within the network.