



Scilab at a glance

Example of implementation at CNES

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Agenda

- Scilab Positioning and Quick Product Description
- The Scilab Consortium
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- Example of Scilab Implementation at CNES
(Presentation courtesy of Franck Reinquin & Audrey Jambois – CNES)
- Conclusion

Scilab Positioning and Quick Product Description

Scilab

The open source platform for numerical computation

Numerical Computation software

- A growing demand,
- Used in research, simulation, control and embedded software generation processes,
- Key success factors for the development & control of the technologies of the future,
- In limited number on the market.

Scilab

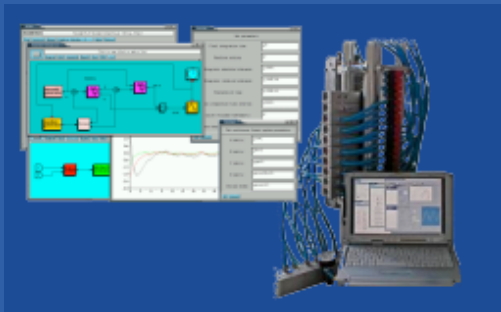
- Broad spectrum **Open Source** numerical computation software,
- Cost effective tool integrating latest scientific contributions,
- Produced by a Consortium hosted by INRIA,
- **Close to 20,000 remote loadings each month,**
- **Yearly Growth 20% !,**
- A comprehensive personal calculation platform,
- A powerful Numerical Calculation Engine easy to embed into applications,
- A foundation for dedicated toolboxes.

Scilab Environment

Runs under:

- Windows 9X/2000/XP
- GNU/Linux (PC, Mac Os X)
- Most UNIX/X Window workstations

Large number of toolboxes:



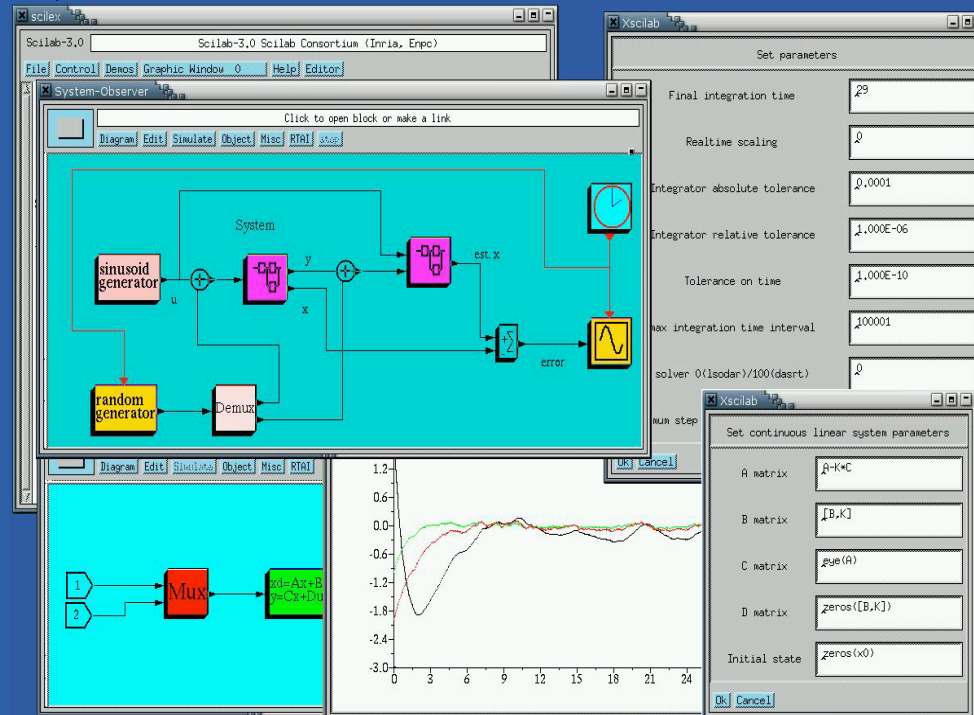
- 2-D and 3-D graphics, animation,
- Linear algebra, sparse matrices,
- Polynomials and rational functions,
- Interpolation, approximation,
- Simulation: explicit and implicit systems of differential equations solution,
- Scicos: block diagram modeler/simulator,
- Classic and robust control, LMI optimization,
- Differentiable and non-differentiable optimization,
- Signal processing,
- Graphs and networks,
- Parallel Scilab,
- Statistics,
- Interfaces with Computer Algebra (Maple),
- Interfaces with Fortran, LabVIEW, Tcl/Tk, C, C++, Java.

Scicos

Hybrid Dynamic Systems

A user-friendly GUI-based editor for modeling dynamical systems as block diagrams.

Scicos is provided with Scilab



Scicos Functionalities

- Hierarchical block diagram structure (super blocks),
- A large number of standard blocks available in various palettes,
- Possibility of defining new blocks using C, Fortran or Scilab language,
- Powerful formalism for modeling:
 - Hybrid systems
 - Implicit systems
 - Non causal systems using Modelica
- Diagram compilation and fast simulation,
- C code generation.

Scilab Major Application Fields

- Any activity which implies the use of algorithms and/or simulation and control.
- To date, major achievements in:
 - Automotive
 - Aviation & Space
 - Energy
 - Research

Current release: Scilab 4.0

(February 15, 2006)

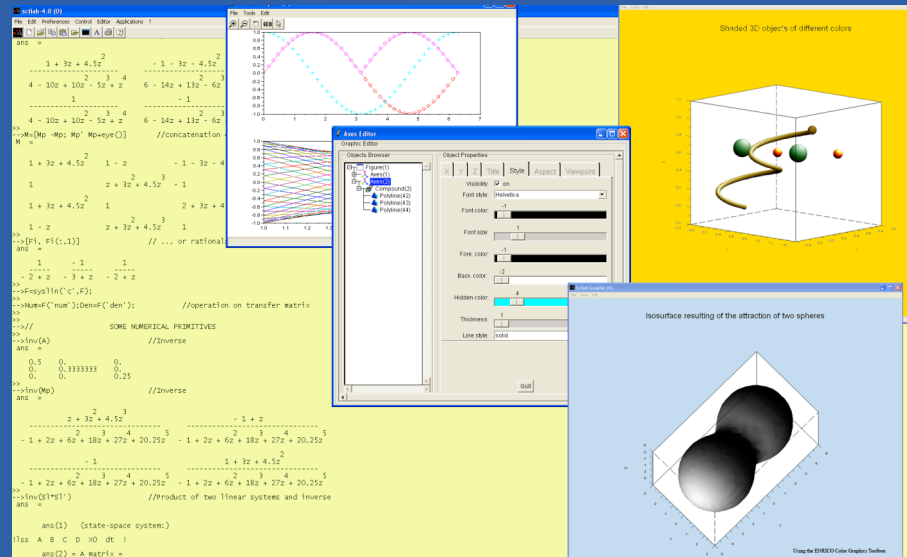
Main features:

- Improved Windows version:
 - Complete integration, virtual memory
 - Compilers, performance (Atlas libraries)
- Object oriented graphics:
 - Enhanced graphics functions (Matlab¹ syntax)
 - Powerful Graphics Editor

- Java interface,
- Import of Excel² files,
- Improved Matlab¹ -> Scilab translator.

¹ Matlab is a trademark of The Mathworks

² Excel is a trademark of Microsoft



Next Major Release: Scilab 5

(Autumn, 2007)

- Easier to use,
- Covering numerical computation needs from basic ones up to high performance computing requests,
- Best performance numerical computation software in selected strategic domains,
- Easier to embed in applications and to interoperate in heterogeneous environments,
- Modular,
- Integrating powerful scientific and technical breakthroughs,
- Based on industry-standard libraries and languages ...

The Scilab Consortium



The Scilab Consortium

Rational & Vision

**Created, by INRIA, in 2003
to answer a widely recognized need
for an Open Source
Numerical Computation Tool
of high quality.**

Scilab Consortium Members

23 Companies & Academics ...

ANAGRAM TECHNOLOGIES, APPEDGE,
ARTENUM, ATMEL, AXS INGENIERIE,
CRIL TECHNOLOGY, CEA, CENTRALE,
CNES, DASSAULT-AVIATION, EADS,
ECOLE POLYTECHNIQUE, EDF, ENPC,
ESTEREL TECHNOLOGIES, IFP, INRIA,
KLIPPEL, PSA, RENAULT, STYREL,
THALES, TNI

...Steadily growing memberships

Scilab Key Players

Inria

French National Institute for Research in Computer Science and Control

- Consortium hosting,
- Legal responsibility,
- Main supplier in engineering breakthroughs,
- Funding.

The Consortium

- Project general management,
- Scilab roadmap decision-making authority,
- Funding.

The Operational Team

- Activity Management,
- Product management,
- Core development,
- Quality assurance,
- First level assistance,
- Contributors community coordination,
- Marketing and promotion.

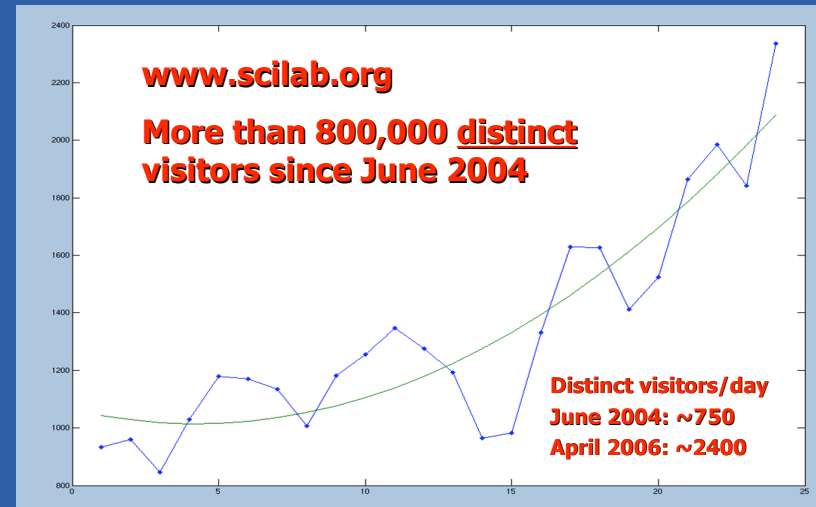
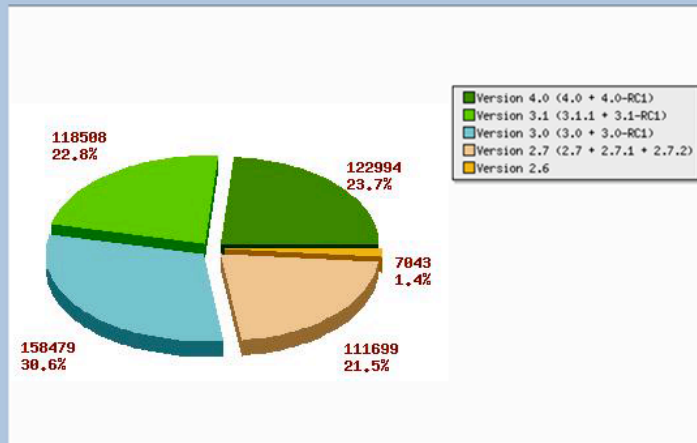
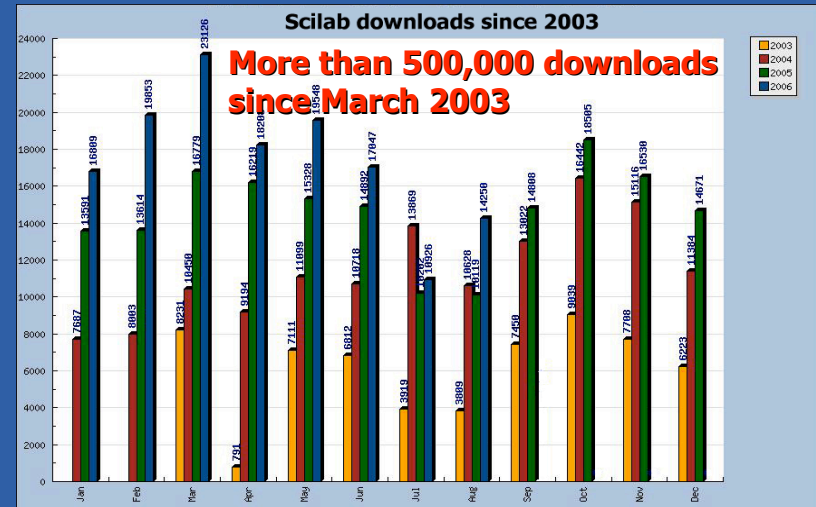
External Contributors

- Specialized toolboxes.

International Presence

An Increasing Market Interest

Scilab 4.0:
Announced February 15, 2006
More than 120,000 downloads
up to now



International Presence



Europe

- Scilab used in the European integrated project hArtes: ATMEL Roma, THALES ...
- **EADS**

France

- Strong presence in engineering of complex systems: **CEA, CNES, Dassault Aviation, EDF, IFP, PSA, Renault, Thales** ...
- Scilab used as the numerical calculation platform in RNTL projects OMD and SCOS,
- Scicos used in RNTL projects SIMPA and ECLIPSE.

Japan

- Collaboration with NII¹.

China

- Represented by LIAMA² since 2001.

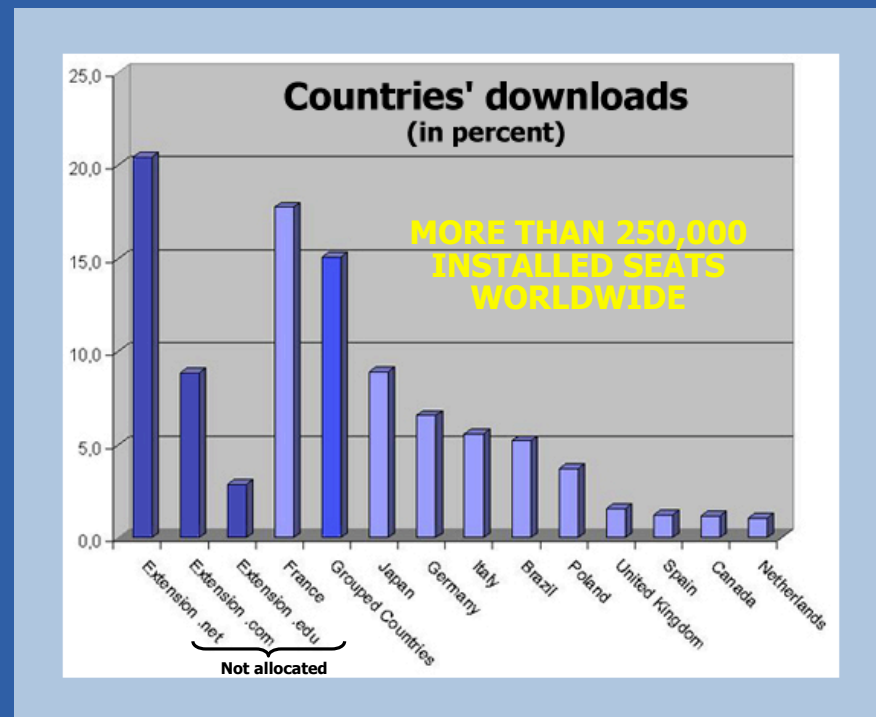
¹ NII: National Institute of Informatics - Japan

² LIAMA: Sino-French Laboratory in Computer Science, Automation and Applied Mathematics

³ NMC: Numerical Mathematics Consortium

North America

- Collaboration with National Instruments,
- Involved in NMC³ numerical calculation standard definition.



2 Major Int'l Outcomes

The hArtes Project

Biggest European funding in Embedded Systems

Develop a tool chain that support automatic or semi-automatic design of complex heterogeneous embedded systems,

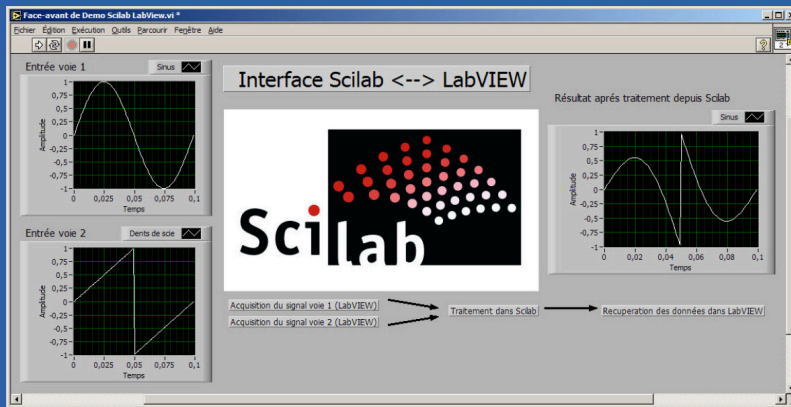
Validate the tool chain on a set of innovative applications in the audio and video field.



- Applications:
FAITAL, Fraunhofer, LIA, Thales, Thomson, UNIVPM.
- Tools & Methodologies:
Imperial College, INRIA Scilab, LEAFF, PoliMi, TU Delft.
- Hardware:
Atmel, Europe Technologies, UNIFE.
- Integration & Proof of concept:
Atmel, FAITAL, Fraunhofer, Thales, Thomson, UNIVPM.

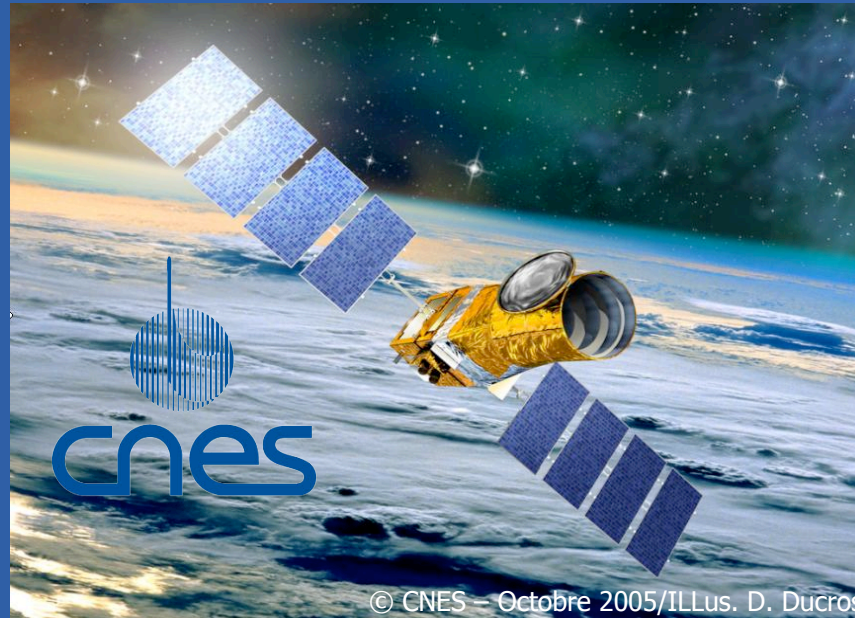


Scilab and LabVIEW™



**Scilab / LabVIEW
gateway
under development
(Beta version announced in August 2006)**

LabVIEW is a trademark of National Instruments.



Interfacing Scilab with CNES widely used MSLIB 90 and MADONA libraries

Presentation courtesy of
Franck Reinquin
& Audrey Jambois
CNES

MSLIB 90 Overview

- MSLIB 90 is a Fortran 90 library, part of CNES flight dynamics software repository,
- Along with several other core libraries, it covers a large spectrum of flight dynamics aspects,
- MSLIB 90 is the successor of first generation MSLIB 77 and takes advantage of its robustness gained through years of operations,
- The current version represents 25 000 lines of Fortran for 152 routines, grouped in thematic sections :
 - Orbit propagation
 - Maneuvers and orbital transfers
 - Basic coordinate systems
 - Solar system ephemerides
 - Orbital parameters and coordinate system conversions
 - Miscellaneous mathematical functions

MSLIB 90 Use

- MSLIB 90 is widely used at CNES in :
 - all ground segments : FDS (Flight Dynamics Centers), mission-related processing centers such as image processing facilities,
 - all mission preparation and analysis tools.
- Usually used from Fortran 90, the library can also be called from C,
- MSLIB90 is tested/used on many UNIX flavors (Solaris, IRIX, Linux, HP-UX, ...) and on Windows.

Sources freely available at: <http://logiciels.cnes.fr> (LGPL-like license)

Scilab Implementation Project

- More and more engineers at CNES use Scilab to perform studies,
- They request to be able to use the valuable collection of existing Fortran 90 libraries, so as to build up a new application quickly and painlessly...
- Some Fortran routines have been put together in a lightweight Scilab framework (called SpaceLab) to be used for the ATV mission analysis,
- First step is to interface MSLIB 90 with Scilab, then integrate the library + its interface into the SpaceLab framework. Then proceed with other libraries.

The way it works

- Illustrative example of a Scilab application which reads an orbit bulletin from a file and displays the trajectory on a map,
- MSLIB 90 library is used for computations, and a dedicated file access library (called MADONA) to read the data.

```
#<AM-acces-V2.0>
```

```
bulletin = {  
  frame = {  
    #Type of frame  
    rep = "Ecliptique moyen"  
    #Time frame  
    ech_date = "2000"  
    #Body rotation speed  
    vrot = "0.7292115373E-04" ~rad/s  
    #Obliquity  
    obli = "0.23439280159E+02" ~deg  
    #Central Body : Earth  
    corcen = "Terre"  
  }  
  ...  
}
```

Orbit
bulletin

Read file
using
MADONA

Compute
using
MSLIB

Draw

Scilab/MADONA
interface

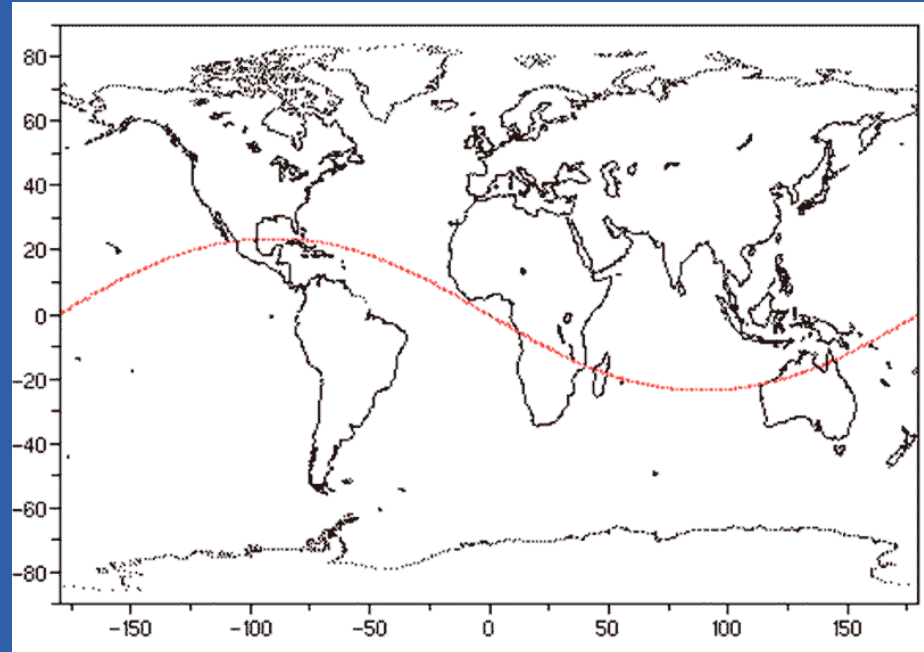
Scilab/MSLIB 90
interface

libMadona.a

libMSLIB.so

Outcome

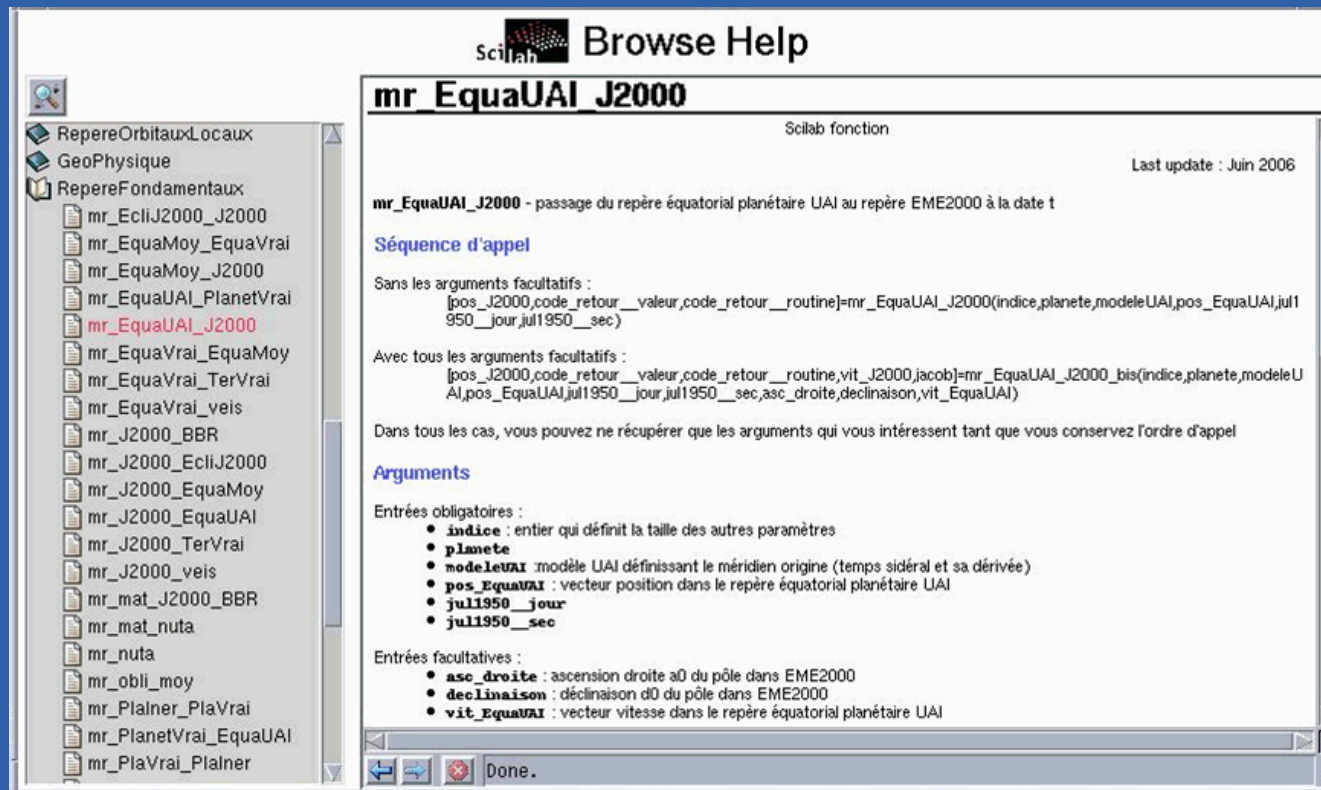
- The required interface layer is automatically generated from the function signatures,
- Easy to use :
 - LINK command : the library and its interface are dynamically loaded,
 - CALL command : creates entry points for each MSLIB 90/MADONA function.



- Numeric precision checked for each function : identical to original call.
- Role of the interface layer :
 - maps each library routine to a Scilab command named after the library routine, with very close syntax (same argument names) : hides the complexity of the CALL function,
 - The Scilab command arguments are vectors/matrices, the library routines are called in a loop inside the interface function → performances.

Side Features

- In-line comment extraction : the online help is automatically generated.
(This feature is effective with the MADONA library ; some information are currently missing in the MSLIB 90 source code headers).



Project Status

- Working prototype, not very far from a final version ; this version is made available internally,
- Still, additional work is required, in order to tackle some points originally bypassed during the prototype development :
 - the MSLIB 90 functions must currently be packed with the interface routines and the FORTRAN system libraries as a single shared library,
 - the FORTRAN optional arguments are currently considered mandatory (sort of),
 - MSLIB 90 functions use a few FORTRAN derived types (structures) ; their Scilab counterpart currently use only simple types (integer, real, ...)
because of the CALL syntax,
- Once the process completed with MSLIB 90 and MADONA, other libraries will follow.

Conclusion

**For your Numerical Computation needs
think Scilab !**



**...and even better, join the
Scilab Consortium**

- **To allow and reinforce further Scilab developments,**
- **To influence the product roadmap according to your needs,**
- **To benefit from attractive members rights.**



Scilab

A software produced by The Scilab Consortium

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