This tutorial corresponds to Magic version 7.

1 Introduction

This version of Magic, version 6, gathers together work done by numerous people at several institutions since Magic version 4 was released from Berkeley on the 1986 VLSI tools tape. This is a release of Magic and IRSIM only. You'll probably want to obtain other tools by ordering the 1986 VLSI Tools Tape from Berkeley.

This release has been prepared with the assistance of several groups. Much of the new software came from Walter Scott's group at the Lawrence Livermore National Labs (LLNL). LLNL also provided partial funding to help prepare the release. Digital Equipment Corporation's Western Research Lab (DECWRL) helped out by providing computer equipment, a place to work, and the services of one of us (Robert Mayo). Don Stark, Michael Arnold, and Gordon Hamachi also worked on the release at DECWRL. Stanford donated significant pieces of new code, including a simulation system called IRSIM. Other individuals and institutions have also contributed code and assistance in ways too numerous to detail here.

New features in Magic Version 6 include:

- New and Improved Routing—*Michael Arnold and Walter Scott of LLNL*
  Three major routing improvements have been made in this version of Magic. There is a new, improved, global router courtesy of Walter Scott (of LLNL). Walter Scott has also added a gate array router. See the "garoute" command in the manual page for details. Michael Arnold (of LLNL) has written an interactive maze router that allows the user to specify hints to control the routing. See the documentation for the "iroute" command.

- Extractor Enhancements—*Don Stark of Stanford and Walter Scott of LLNL*
  The new "extresis" command, developed by Don Stark, provides substantially better resistance extraction. Magic's normal extraction ("extract") lumps resistances on a node into a single value. In branching networks, this approximation is often not acceptable. Resis was written to solve this problem. Walter Scott added accurate path length extraction, an important feature when dealing with high speed circuits, such as ECL.

- New contact structure—*Walter Scott and Michael Arnold of LLNL and Don Stark of Stanford*
  Multilayer contacts are handled better. In the previous version of Magic, there needed to be a separate contact type for each possible combination of contact layers over a given point. This caused a combinatorial explosion of tile types for multi-layer technologies with stacked contacts. Under the new scheme, there are only a couple of tile types for each layer: one that connects up, one that connects down, and one that connects in both directions.

- Simulator Interface to IRSIM—*Stanford*
  A simulator interface is provided courtesy of Stanford. See the commands "startrsim", "simcmd", and "rsim". The irsim simulator, Stanford's much improved rewrite of esim, is included in this distribution. Credit goes to Mike Chow, Arturo Salz, and Mark Horowitz.

- New device/machine Support—*Various*
  X11 is fully supported in this release, and is the preferred interface. Older drivers for graphics terminals and X10 are also included, but X11 is the preferred interface (meaning it is better supported and you'll have lots of company). Magic's X11 driver has a long history, starting with an X10 driver by Doug Pan at Stanford. Brown University, the University of Southern California, the University of Washington, and Lawrence Livermore National Labs all prepared improved versions, some of them for X11. Don Stark of Stanford took on the task of pulling these together and producing the X11 driver in this release.

  Magic runs on a number of workstations, such as the DECstation 3100 and Sun's SPARC processors. Partial Unix System V support is provided, via the compilation flags mentioned below. The system also runs on the MacII. Don Stark gets credit for the System V mods and support for HP machines, while Mike Chow helped get it running on the MacII.

  To assist people with small machines (such as the Mac II), Magic can now be compiled without some of its fancy features. Compilation flags are provided, as indicated below, to eliminate things like routing, plotting, or calma output. This is courtesy of Don Stark.

- Reorganization of Magic Source Directory
  Magic, as previously distributed, was set up with the assumption that lots of people would be changing the code at the same time. As a result, the makefiles did all sorts of paranoid things like making extra copies of the source code whenever a module was re-installed.

  Since Magic is more stable now, this copying is no longer needed. Instead, each makefile invokes the script **../:instclean** after installing a module. This script, by default, doesn't copy the source code but does leave the .o files around. This cuts down on the disk space needed by a factor of two. You can change the script if you want the copying, or if you want to delete unused .o files to save even more disk space.

- Lots of bug fixes—*Various*
  Lots of bugs have been fixed in this release. We'd like to thank everybody that has reported bugs in the past. If you find a new bug, please report it as mentioned below.

2 Distribution Information

This version of Magic is available via FTP. Contact "`magic@decwrl.dec.com`" for information.

For a handling fee, this version of Magic may be obtained on magnetic tape from:

EECS/ERL Industrial Liaison Program
479 Cory Hall
University of California at Berkeley
Berkeley, CA 94720

3 Bug Reports

Maintenance of Magic is a volunteer effort. Please send descriptions of bugs via InterNet e-mail to "`magic@decwrl.dec.com`" or via Uucp e-mail to "`decwrl!magic`". If you develop a fix for the problem, please send that too!

4 Changes for Magic maintainers

Previous releases of Magic expected to find their system files in the home directory of the user **cad**. The default behavior of version 6 is no different, but it is possible to put the files in another directory by setting the **CAD_HOME** shell environment variable. If this variable is set, magic will use that location instead of the ˜cad it finds in the password file.

4.1 INSTALLING MAGIC

The distribution tape contains a version of Magic ready to run on Digital's line of Ultrix RISC workstations, such as the DECstation 3100. For other machines, read ahead. In any event, all users should set their shell environment variable CAD_HOME to point to the place where the tape is loaded, unless that place is ˜cad, in which case things will default correctly.

Before installing Magic, you should set your shell environment variable CAD_HOME to point to the place where you loaded the tape. If you "cd" to the magic source directory ($CAD_HOME/src/magic) you will find a makefile. A "**make config**" will run a configuration script that asks questions about your configuration and sets up magic to be compiled for your local environment.

After running a "make config", you can run a "**make force**" to force a complete recompilation of magic. A "**make install**" will then copy the binaries to the $CAD_HOME/bin area, as well as install things in $CAD_HOME/lib and $CAD_HOME/man.

Included in this documentation is a set of Magic maintainer's manuals. These should be read by anybody interested in modifying Magic or by anybody that is having difficulty installing it on their system.

4.2 Technology file changes

Users of Magic 4 should have little trouble switching to Magic 6.

A new section, the **mzrouter** section needs to be added to your technology files. See the mzrouter section of the tutorial *Magic Maintainer's Manual #2: The Technology File* for details.

Display styles must be defined in the *.tech* file for the mzrouter hint layers magnet, fence and rotate. We suggest copying this information from the styles section of the scmos technology file on the distribution tape. You'll also need to include these display styles in your *.dstyle* file.

5 Beta-test Sites

We'd like to thank the beta-test sites that tried out this version of Magic, reported bugs and fixes in a timely manner, and ported the code to new machines:

Mike Chow, Apple Computer
Arun Rao, Arizona State University
Richard Hughey, Brown University
Rick Carley, Carnegie-Mellon University
Hank Walker, Carnegie-Mellon University
Christos Zoulas, Cornell University
Andreas Andreou, John Hopkins University
George Entenman, The Microelectronics Center of North Carolina
Shih-Lien Lu, The MOSIS Service
Jen-I Pi, The MOSIS Service
Guntram Wolski, Silicon Engineering, Inc.
Don Stark, Stanford University
Gregory Frazier, University of California at Los Angeles
Yuval Tamir, University of California at Los Angeles
Steven Parkes, University of Illinois
Larry McMurchie, University of Washington
Tim Heldt, Washington State University
David Lee, Xerox Palo Alto Research Center

Martin Harriman of Silicon Engineering wrote a “select less” command for Magic during the beta-test phase. “Select less” has been a much-requested feature.

In addition to the persons named above, there were many other beta-test users of Magic at these and other sites—too many to list here. We appreciate their help. We also acknowledge the help of the pre-release sites, who tested a version that included most of the fixes from the beta-test phase.