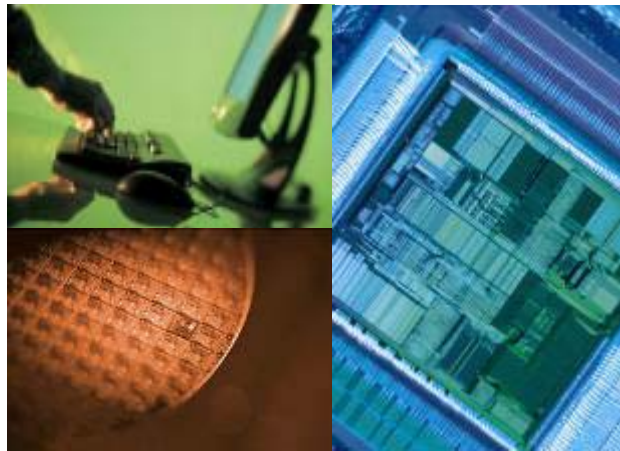


Using LEF/DEF Translators in the MAP-inSM Program

EDA Interoperability Developers' Forum
November 9, 2006



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SMD Alliance Manager

Somil Ingle
Library CAE

Agenda

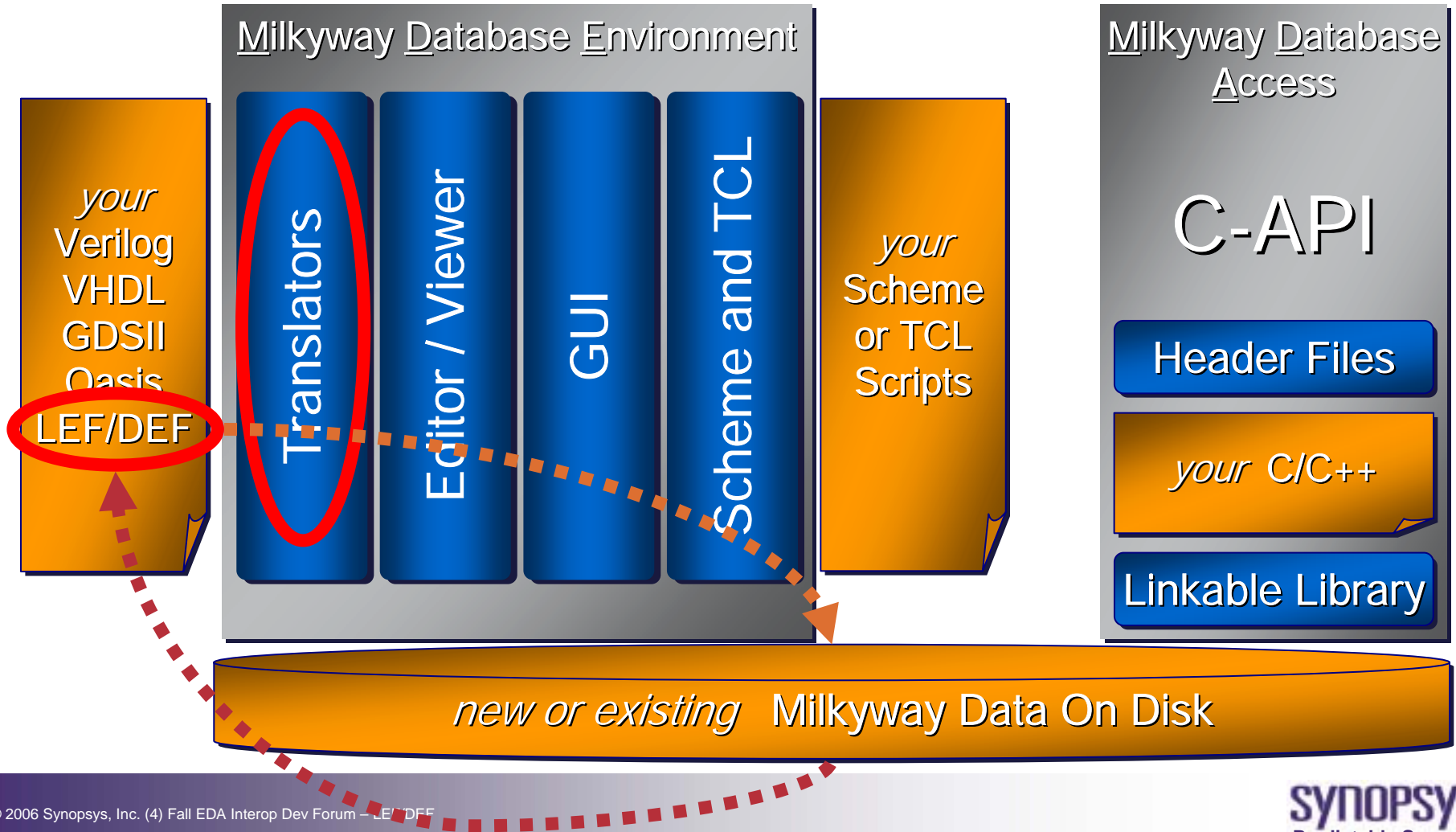
- MAP-in program overview of MDE and translators
- LEF / DEF overview
- LEF / DEF translators structure then and now
- Improvements in LEF In ...
- LEF and DEF in the library data preparation
- Some LEF/DEF FAQ
- Summary

MAP-inSM – Milkyway Access Program

- **Free and open to all EDA vendors**
 - 40+ licensees with recent bursts of activity
 - Products available today
- **Comprehensive environment**
 - GUI, viewer, editor, translators
 - Scheme and TCL scripting
 - Fast C-API access to read, modify, and/or create
- **One Milkyway code-base**
 - Simultaneous releases
 - Forward and backward compatibility

MAP-in Components

Documentation and Examples



LEF/DEF Overview

- Developed by another large EDA vendor.
- Definition and support is now hosted by Si2.
<http://openeda.si2.org/projects/lefdef/>
- Synopsys LEF and DEF translators are to and from Milkyway rather to and from individual tools.
- Single set of translators guaranties consistency.

LEF/DEF Definitions

- LEF – Library Exchange Format
 - Contains standard cells, macros, and I/O cells
 - Created and shipped by library vendors
 - Used to build Milkyway reference libraries

- DEF – Design Exchange Format
 - Contains design netlist and floorplan information
 - Output by physical design tools
 - Used to build Milkyway design libraries

MAP-in LEF/DEF Translators

*MAP-in partners get the **exact same translators** as our customers.*

- The Milkyway Database Environment ‘**mde**’ is a version of the ‘Milkyway’ data preparation tool supplied to MAP-in members.
- There are other executables in the same directory as ‘mde’, including:
 - A2Def, A2Lef, def2A, lef2A
 - These are OLDER versions of our LEF/DEF support.
You almost certainly do not want to use them.
- Since 2004.06 we have had LEF/DEF support built-in to ‘mde’ (and other executables such as ‘Astro’).

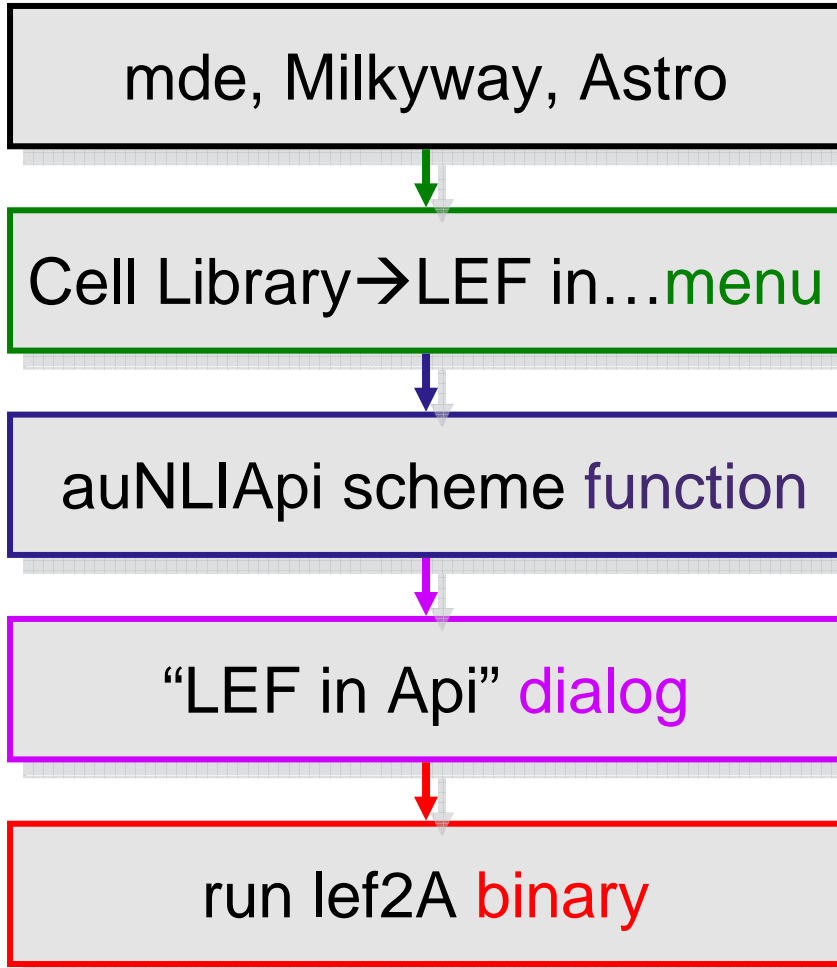
MDE binaries

```
? ls -l ~mwcae/Release-center/MAPin/2006.06/QA/mapin_Y-2006.06/bin/IA.32
total 80260
```

```
-PWXF-XF-X 1 mwcae synopsys 4051236 2006-08-28 14:59 A2Def
-PWXF-XF-X 1 mwcae synopsys 3423100 2006-08-28 14:59 A2Edif
-PWXF-XF-X 1 mwcae synopsys 4750972 2006-08-28 14:59 A2Hdl
-PWXF-XF-X 1 mwcae synopsys 4878092 2006-08-28 14:59 A2Lef
-PWXF-XF-X 1 mwcae synopsys 5362152 2006-08-28 14:59 A2Vhdl
-PWXF-XF-X 1 mwcae synopsys 5031548 2006-08-28 14:59 alf2clf
-PWXF-XF-X 1 mwcae synopsys 408224 2006-08-28 14:59 AMonitor
-PWXF-XF-X 1 mwcae synopsys 425352 2006-08-28 14:59 AServer
-PWXF-XF-X 1 mwcae synopsys 5314692 2006-08-28 14:59 def2A
-PWXF-XF-X 1 mwcae synopsys 3575680 2006-08-28 14:59 edif2A
-PWXF-XF-X 1 mwcae synopsys 4751868 2006-08-28 14:59 hdl2A
-PWXF-XF-X 1 mwcae synopsys 6083192 2006-08-28 14:59 lef2A
-PWXF-XF-X 1 mwcae synopsys 755324 2006-08-22 15:35 lndown
-PWXF-XF-X 1 mwcae synopsys 770456 2006-08-22 15:35 lmgrd
-PWXF-XF-X 1 mwcae synopsys 755324 2006-08-22 15:35 lostat
-PWXF-XF-X 1 mwcae synopsys 755324 2006-08-22 15:35 lutil
-PWXF-XF-X 1 mwcae synopsys 755324 2006-08-22 15:35 lver
-PWXF-XF-X 1 mwcae synopsys 21847096 2006-08-28 14:59 mde
-PWXF-XF-X 1 mwcae synopsys 241714 2006-06-08 18:39 NullXServer
-PWXF-XF-X 1 mwcae synopsys 1027899 2006-06-08 18:39 NullXServer2
-PWXF-XF-X 1 mwcae synopsys 1673628 2006-08-28 14:59 snpslnd
-PWXF-XF-X 1 mwcae synopsys 5361032 2006-08-28 14:59 vhd12A
```

what NOT to use!

LEF/DEF translators (old style):



- LEF In ...
 - Cell Library → LEF In ... menu
 - auNLIApi function
 - "LEF In API" dialog
 - lef2A binary
- DEF In ...
 - Netlist In → DEF In ... menu
 - auNDIApi function
 - "DEF In API" dialog
 - def2A binary
- LEF Out ...
 - Output → LEF Out ... menu
 - auNLOApi function
 - "LEF Out API" dialog
 - A2Lef binary
- DEF Out ...
 - Output → DEF In ... menu
 - auNDOApi function
 - "DEF Out API" dialog
 - A2Def binary

LEF/DEF in 2003, 2004 MAP-in

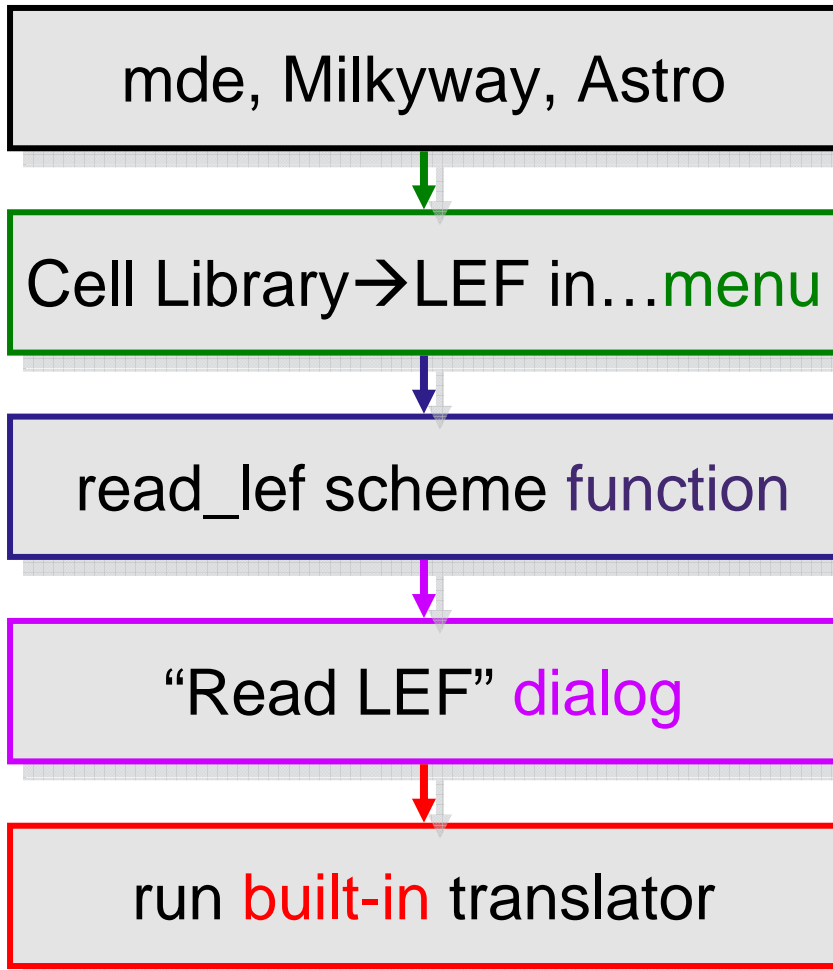
- 2003.09 – *all translators external*
 - Translators are all external binaries: lef2A, def2A, A2Lef, A2Def
 - Called by: auNLIApi, auNDIApi, auNLOApi, auNLOApi from all menus
- 2004.06 – *integrated translators introduced*
 - Same as 2003 with binaries and auNxxApi from menus
 - First integrated versions: read_lef, read_def, and write_def

LEF/DEF in 2005, 2006 MAP-in

- 2005.09 – *menus changed to new translators except for LEF Out*
 - All previous functions still available as commands but
 - Cell Library-LEF In..., Netlist In-DEF In..., Output-DEF Out... menus invoke integrated versions (read_lef, read_def, write_def)
 - Output-LEF Out... still invokes auNDOApi and external binary A2Lef

- 2006.06 – *old DEF commands removed, write_lef becomes available as command to mde users*
 - auNDIApi and auNDOApi are gone
 - Menus invoke same combination as in 2005.09
 - write_lef available from command line
 - All binaries lef2A, def2A, A2Lef, A2Def still present

LEF/DEF translators (new style):



- LEF In ...
 - Cell Library -> LEF In ... menu
 - read_lef function
 - "Read LEF" dialog
 - run built-in translator
- DEF In ...
 - Netlist In -> DEF In ... menu
 - read_def function
 - "read def" dialog
 - run built-in translator
- LEF Out ... (as of 2006.06)
 - Menu invokes old version
 - write_lef invokes new "write lef"
- DEF Out ...
 - Output -> DEF In ... menu
 - write_def function
 - "Write Def" dialog
 - run built-in translator

```
Shell - Konsole <2>
Session Edit View Bookmarks Settings Help
coper12:/remote/arda/brevard/milkyway-examples 0.981 \
? -mcaee/Release-center/MAPin/2006.06/qa/wapin_Y-2006.06/bin/IA_32/mde
Checkout of "MDataPrep" failed. license server does not support this version of this feature (-25,147).
Checkout of "MDataLink" failed. license server does not support this version of this feature (-25,147).
Checkout of "MDataAccess" failed. license server does not support this version of this feature (-25,147).
License initialization failed
No PseudoColor Visual available, try trueColor instead
Starting a non page replacement mode Milkyway @ session...
```

```
mde : milkyway-examples
Tools Library Cell Options Views Create Modify Select Query
Tech File Netlist In Cell Library Output
          mde (TM)
          Version Y-2006.06-Prod for IA_32 -- Mon Aug 28 11:44:43 PDT 2006

Linux 2.4.21-30.ELkuyeswa #1 SMP Fri Apr 15 21:04:31 EDT 2005 i686
Host: coper12 [IA_32]

Copyright (C) 1991-2005 Synopsys, Inc. All rights reserved.
Your use of this program is subject to the terms and conditions of
a written license agreement between you, or your company, and Synopsys.
Use the Tcl command "help about" for additional information about
certain restrictions on your use of this software and its inputs and outputs.
Install Path: /remote/cse825/mcaee/Release-center/MAPin/2006.06/qa/wapin_Y-2006.06

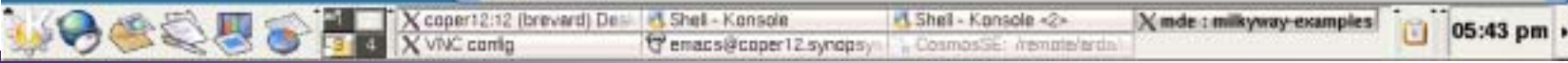
Loading /remote/cse825/mcaee/Release-center/MAPin/2006.06/qa/wapin_Y-2006.06/etc/scheme
/.senvic
#c
Info: loading setup file(s)
Info: sourcing installation .synopsys_milkyway.tcl, version 1004.06.04
Initialization completed

----- Begin Scheme mode. For Tcl, type begin_tcl or click the Tcl button
----- To run tcl script, use "source"

Command History
configureWindow 0 *25x24+0+0
configureWindow 0 *25x24+72+17
configureWindow 0 *25x24+44+21
configureWindow 0 *25x46+44+21
configureWindow 0 *25x46+44+21
configureWindow 0 *25x46+368+2

Scheme Tcl Ready
```

Running 'mde'



MDE in 2006.06 MAP-in

```
mde : milkyway-examples
Tools      Library  Cell  Options  Views  Create  Modify  Select  Query
Tech File  Netlist In  Cell Library  Output

mde (TM)
Version Y-2006.06-Prod for IA.32 -- Mon Aug 28 11:44:43 PDT 2006

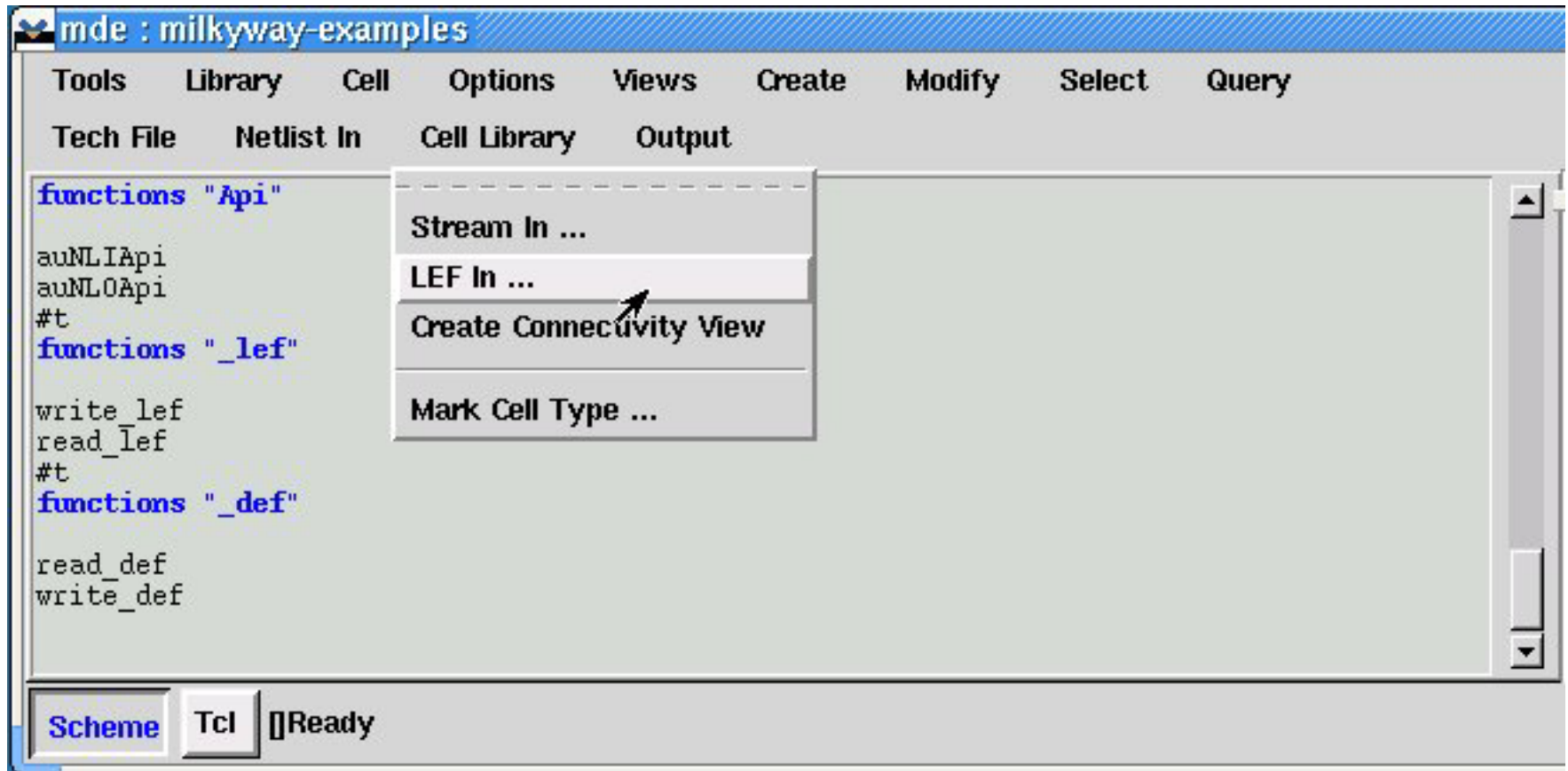
Linux 2.4.21-32.ELhugemem #1 SMP Fri Apr 15 21:04:31 EDT 2005 i686
Host: coper12 (IA.32)

Copyright (C) 1991-2005 Synopsys, Inc. All rights reserved.
Your use of this program is subject to the terms and conditions of
a written license agreement between you, or your company, and Synopsys.
Use the Tcl command "help about" for additional information about
certain restrictions on your use of this software and its inputs and outputs.
Install Path: /remote/cae826/mwcae/Release-center/MAPin/2006.06/QA/mapin_Y-2006.06

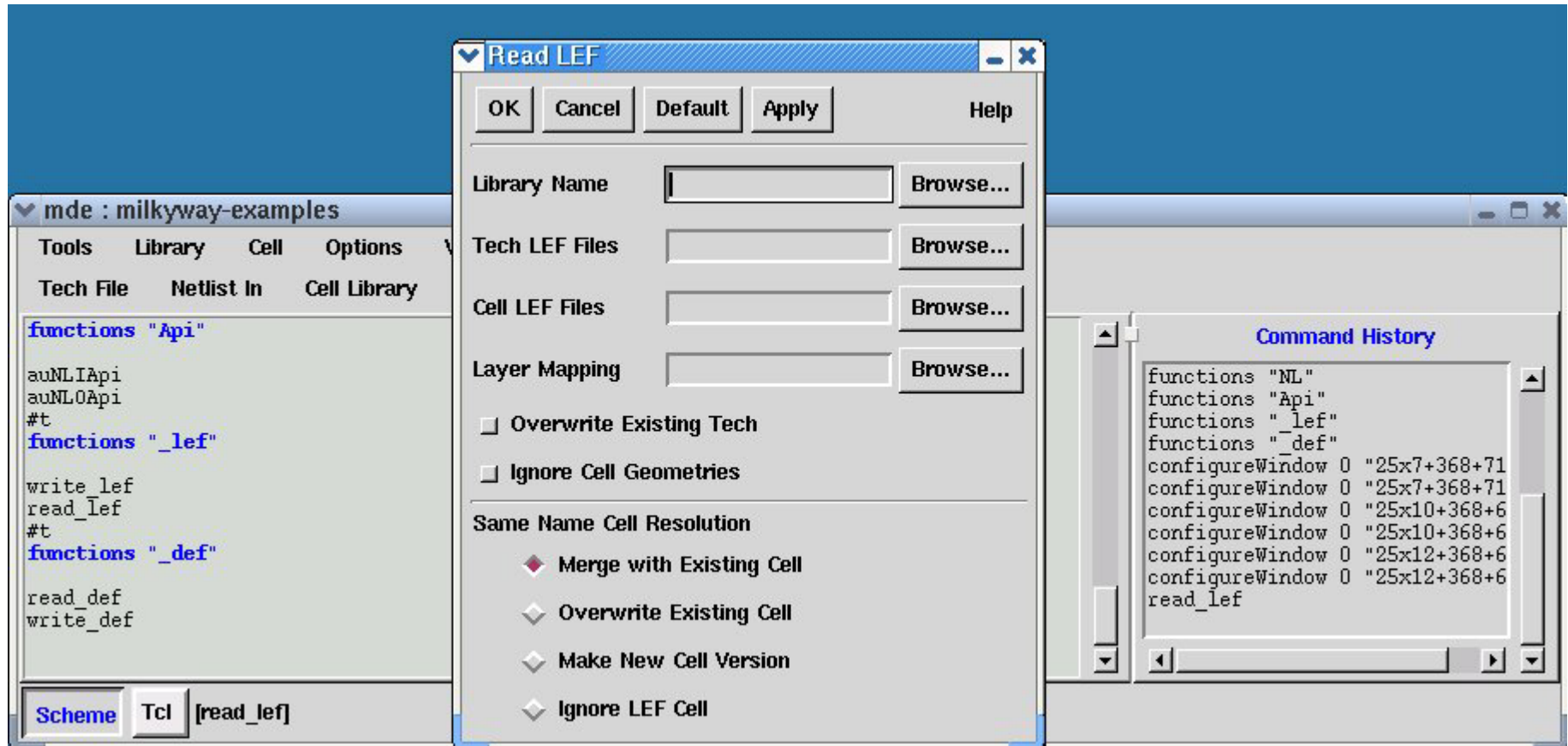
Loading /remote/cae826/mwcae/Release-center/MAPin/2006.06/QA/mapin_Y-2006.06/etc/scheme
/.avntrc
#t
Info: loading setup file(s)
Info: sourcing installation .synopsys_milkyway.tcl, version 2004.06.04
Initialization completed

----- Begin Scheme mode. For Tcl, type begin_tcl or click the Tcl button
----- To run tcl script, use "source"
```

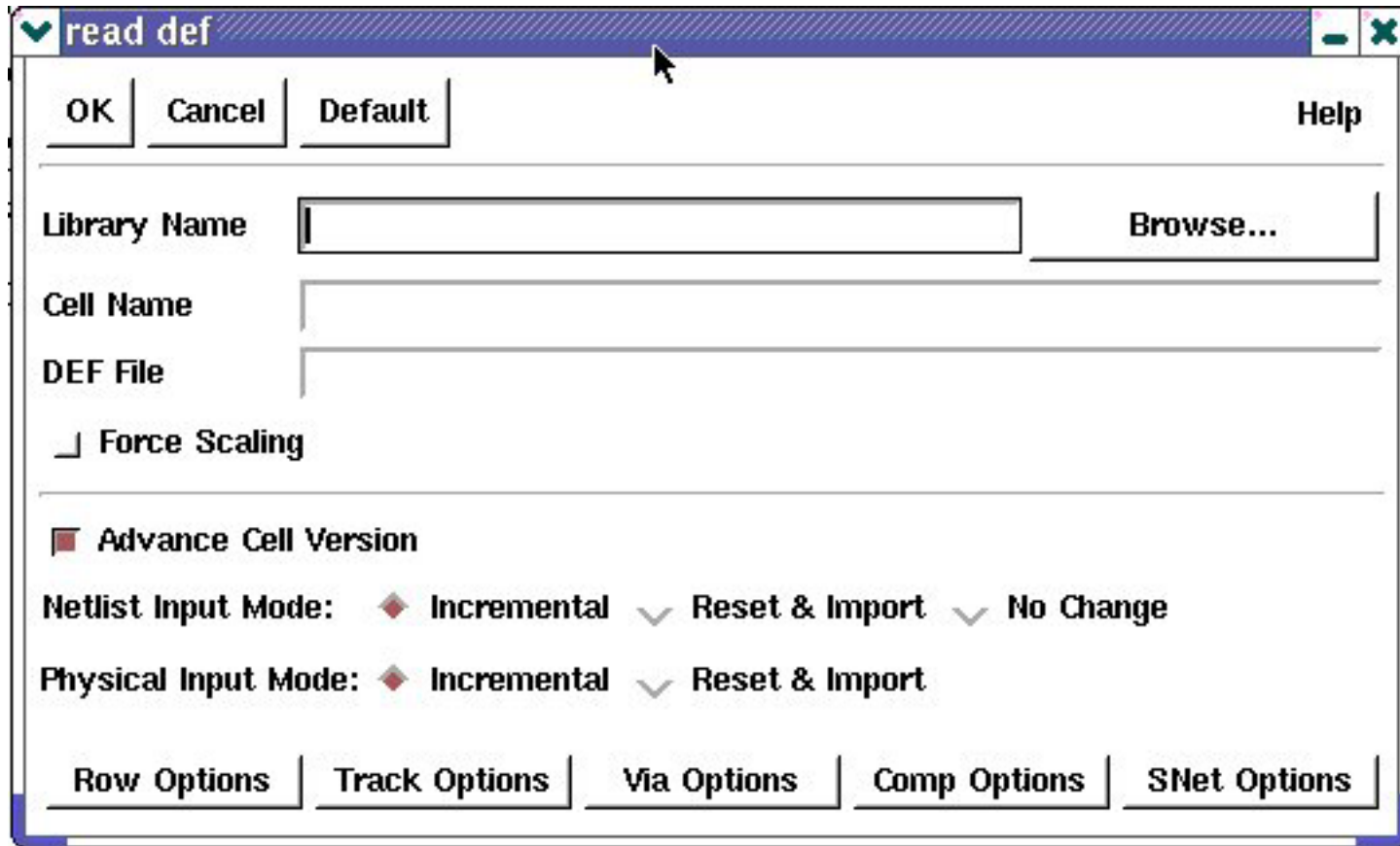
MDE functions and LEF In ... menu



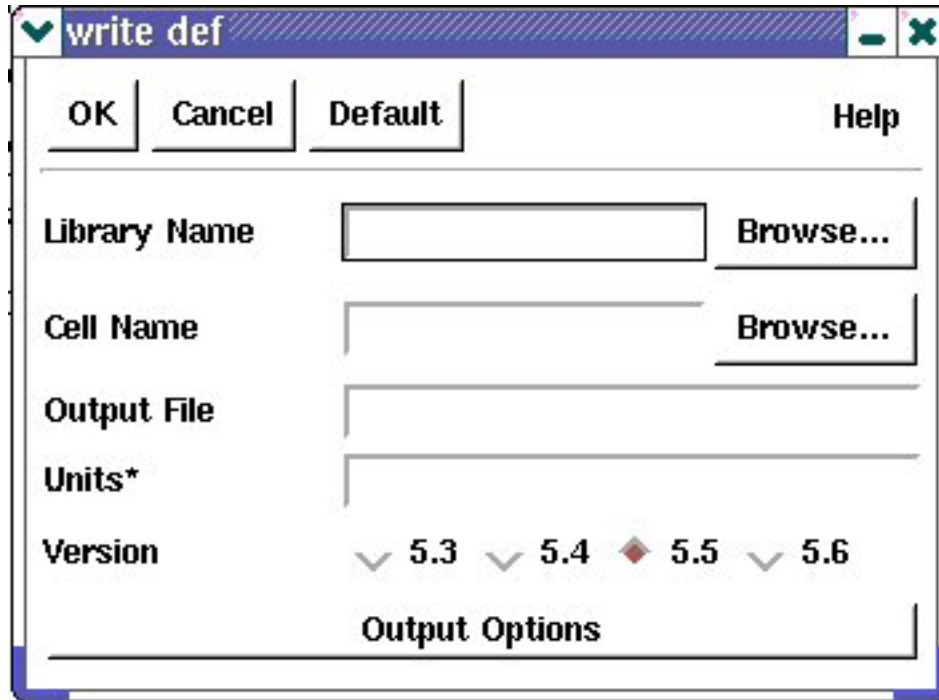
Menu: Cell Library > LEF In ... invokes read_lef command dialog:



Menu: Netlist In > DEF In ... invokes read_def command dialog:

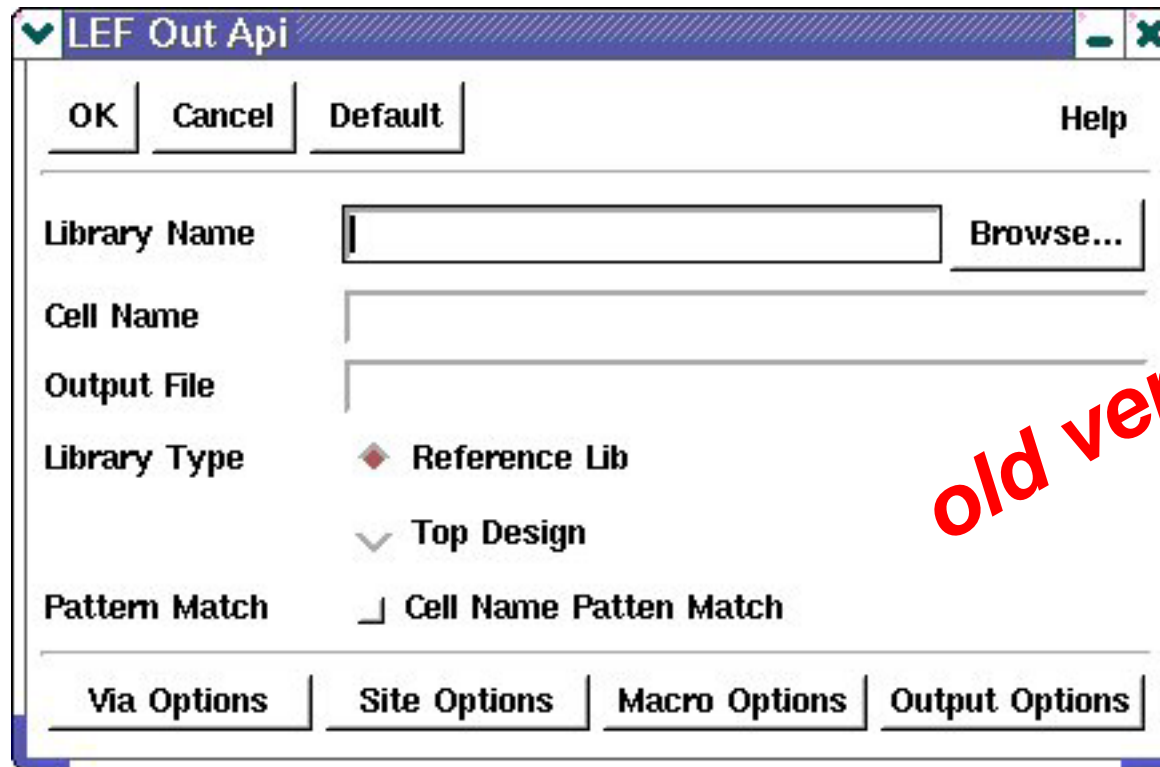


Menu: Output > DEF Out ... invokes write_def command dialog:



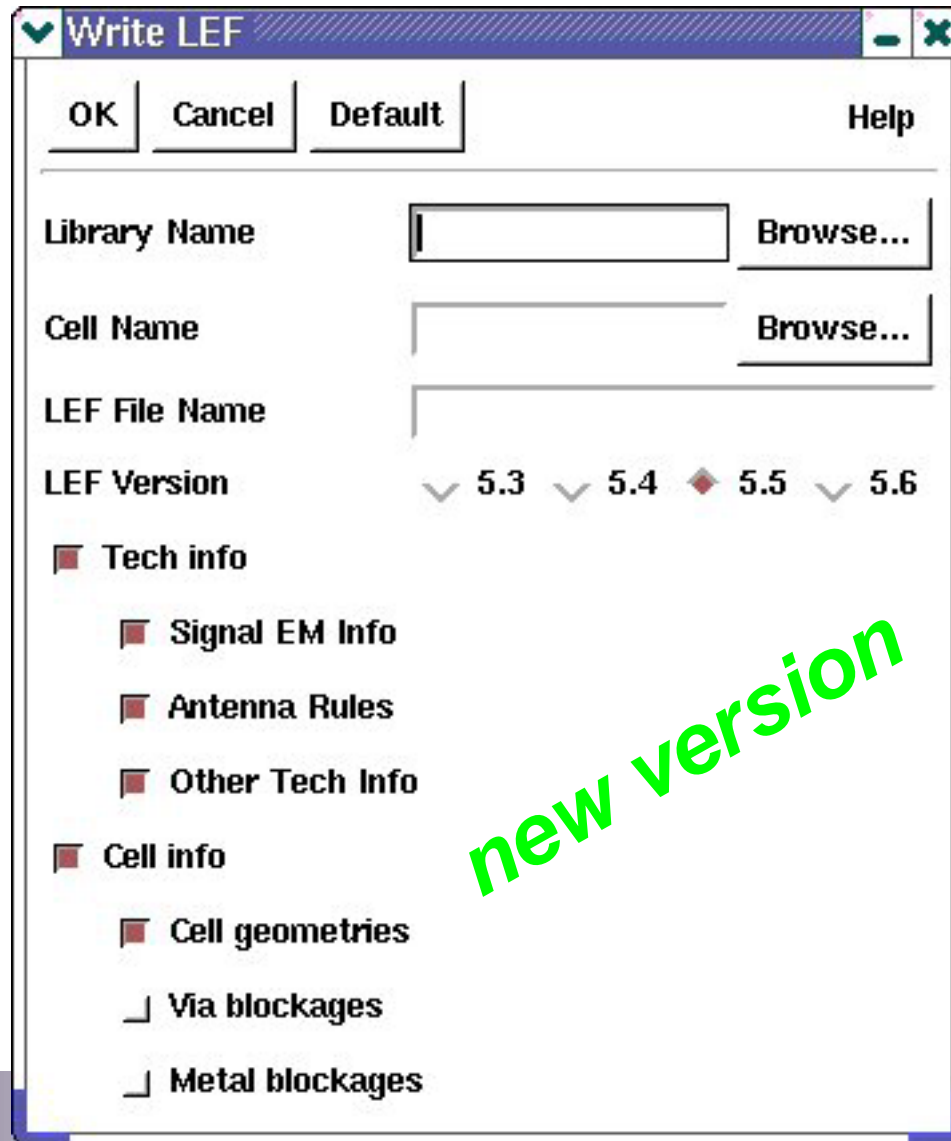
Menu: Output > LEF Out...

invokes auNLOApi command dialog:



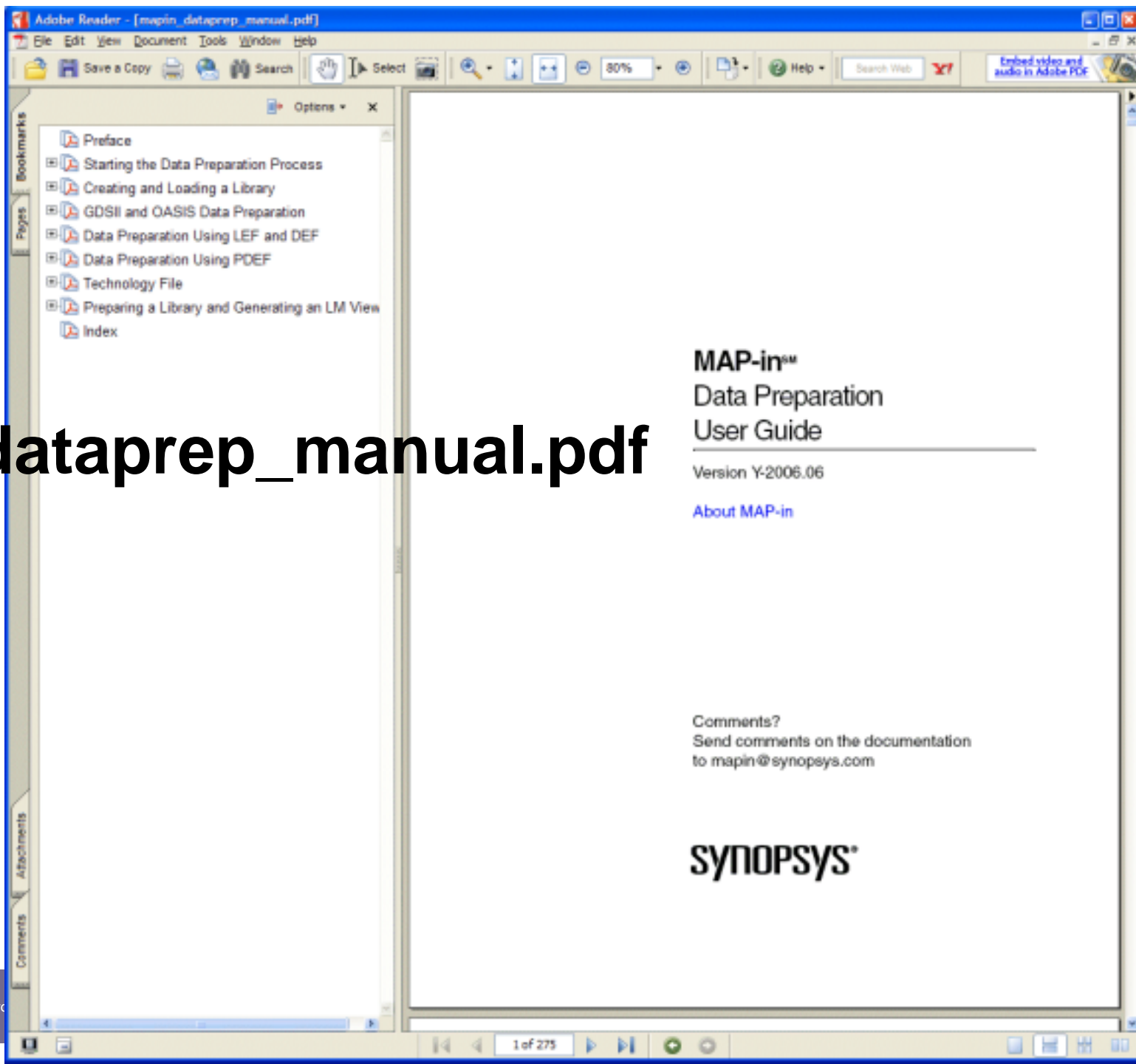
Command: write_lef

invokes Write LEF command dialog:



LEF In... with read_lef

- Previous auNLIApi / lef2A of limited use to MAP-in
 - Post processing with smash and BPV extract not available
 - Library required to already exist
 - Tech file required to create library but you had to craft the tech file to match technology in the LEF file
 - In practice many iterations required and could not create correct FRAM abstracts
- New read_lef
 - Can create the Milkyway library from scratch
 - Runs the smash and extract internally
 - Much more usable reference libraries are created



mapin_dataprep_manual.pdf

MAP-inSM
Data Preparation
User Guide

Version Y-2006.06

[About MAP-in](#)

Comments?
Send comments on the documentation
to mapin@synopsys.com

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Library Preparation Using LEF *page 4-2 (page 74 of pdf)*

In addition to GDSII, the Library Exchange Format (LEF) is another method of providing library information from a third-party database to Milkyway. LEF defines the elements of an IC process technology and associated library of cell models and contains library information for a class of designs. This library data includes layer, via, placement site type, and macro cell definitions. Milkyway supports all LEF versions, including version 5.6.

The command for importing LEF data is `read_lef` for standard and nonstandard cells. The `read_lef` flow is automated and provides complete translation for LEF syntax.

This section describes the process of importing LEF data to create a Milkyway reference library and contains the following subsections:

- [Creating a Milkyway Library Using `read_lef`](#)
- [Generated Files](#)
- [Comparison Between `auNLIapi` and `read_lef`](#)

read_lef flow for standard cells

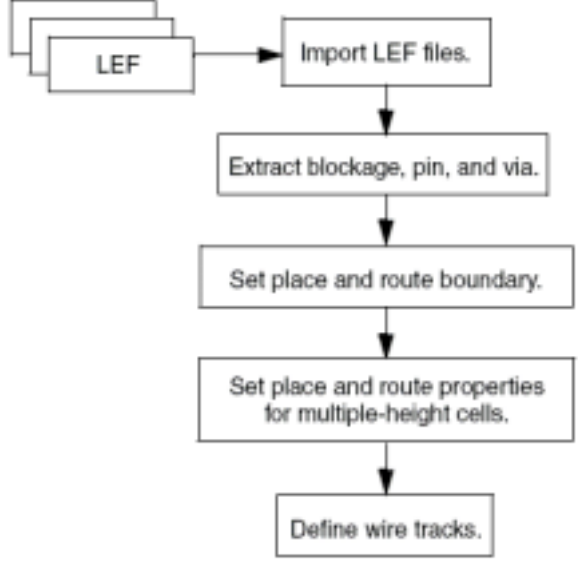
Adobe Reader - [mapin_dataprep_manual.pdf]

File Edit View Document Tools Window Help

Save a Copy Select 117% Help Search Web Create Adobe PDF online for free

Figure 4-2 shows the `read_lef` flow for creating a Milkyway library for standard cells.

Figure 4-2 `read_lef` Flow for Standard Cells



```
graph TD; LEF[LEF] --> Import[Import LEF files.]; Import --> Extract[Extract blockage, pin, and via.]; Extract --> Boundary[Set place and route boundary.]; Boundary --> Properties[Set place and route properties for multiple-height cells.]; Properties --> Tracks[Define wire tracks.];
```

Figure 4-3 shows the `read_lef` flow for nonstandard cells using a two-step automated process. Note that the `read_lef` flow runs through all steps shown in Figure 4-2. Using the automated `read_lef` flow for nonstandard cells, you can ignore any error messages that might be reported in the last three steps.

76 of 275

Extensive comparison of old auNLIApi and read_lef in manual

- See Table 4-1 on pages 4-15 (page 87 of pdf) through 4-19 (page 91 of pdf)

The Milkyway DEF Interface

Starting at page 4-20 (page 92 of pdf)

The Design Exchange Format (DEF) defines the elements of an IC design relevant to the physical layout, including the netlist and design constraints. It contains the design-specific information for a circuit and is a representation of the design at any point during the layout process.

The Milkyway DEF interface discussed in this section uses a common new DEF reader and writer to provide consistency between Synopsys tools.

Note: The auNDIApi and auNDOApi commands are no longer supported.

The DEF interface supports versions 5.3, 5.4, 5.5, and 5.6.

This section includes the following subsections:

- DEF Import and Export Commands
- Importing DEF Data Into Milkyway Using read_def
- Exporting DEF From Milkyway Using write_def
- Recommended DEF Flows
- Supported DEF 5.6 Syntax

DEF versus GDSII

- DEF includes additional information
- Electrical connectivity (netlist)
- Floorplan
 - Physical pin locations
 - Sites
- Routing information
 - Cell rows
 - Wire tracks

What about LEF Out ... ?

- LEF Out ... is not documented MAP-in
- Its usage is discouraged.

Because...

- LEF Out ... will output LEF that matches Milkyway usage with respect to physical abstracts – our FRAM view
- It is unlikely this will match cell abstracts needed by other place and route tools.

LEF/DEF Version Support

- Always use the newest LEF/DEF translators.
- All versions through 5.6 are now supported with selectable output back to 5.3

LEF/DEF FAQ 1

Which LEF/DEF version is currently supported in Milkyway?

Answer:

mde/Milkyway/Astro/Jupiter/ICC support
v5.3, v5.4, v5.5 and v5.6

Physical Compiler does not support 5.6

LEF/DEF FAQ 2

**I have different cells in the CEL and FRAM views.
Which cells are dumped out to output LEF file
when I do LEF out?**

Answer:

All the cells in FRAM view are dumped out when you dump out a LEF file from Milkyway library

LEF/DEF FAQ 3

When I do LEF in, apart from the cells in the MACRO section of the LEF, some VIA cells are also created in the CEL directory. Why?

Answer:

LEF In is supposed to create the VIA cells. The VIA cell contains all information of VIA, including cut geometry, metal enclosure, internal net connection, and so on. This VIA cell will be useful in the later stages like placement and routing.

LEF/DEF FAQ 4

Can I do LEF out without FRAM view?

Answer:

No.

A cell must have FRAM view. Otherwise, it will not be written in the output LEF file. The LEF Out process extracts as much information as possible from the FRAM view and outputs into LEF “dot model” form.

LEF/DEF FAQ 5

Can I do LEF in without the Tech file?

Answer:

Yes as long as the input LEF file has technology information.

You can create a new Milkyway Library from LEF without having a tf file using read_lef.

LEF/DEF FAQ 6

After LEF in creates a FRAM view cell, the Access Direction field is empty but the Pin Direction is there. What is the difference between the Access Direction and Pin Direction?

Answer:

Pin direction is for signal direction. It has different types such as In/Out/InOut.

Access direction is for routing access. It has different types such as right/left/top/down.

Summary

- LEF / DEF support in Milkyway has been evolving over the last few years.
- Our older LEF / DEF support had a (deserved) reputation for not working very well.
- Library preparation could take a long time even in the hands of an expert.
- The new translators are much more automated and user-friendly.
- Creation of a Milkyway library from only LEF/DEF is now possible.

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