

OASIS Implementation: A Synopsys Perspective

John Petty
Staff Engineer
WW Application Services

J. Tracy Weed , Ph.D.
Director
Manufacturing Enabling
Products Group

Synopsys Involvement in Standards

- Synopsys supports and actively participates in many standards efforts
 - OASIS, Verilog, SystemVerilog, VHDL, EDIF, SPF, SDF, BSIM,
- Member of OASIS SEMI DP Taskforce from inception
- **Open Artwork System Interchange Standard**
 - Efficient hierarchical and flat representation of mask layout geometry
 - Likely replacement for GDSII

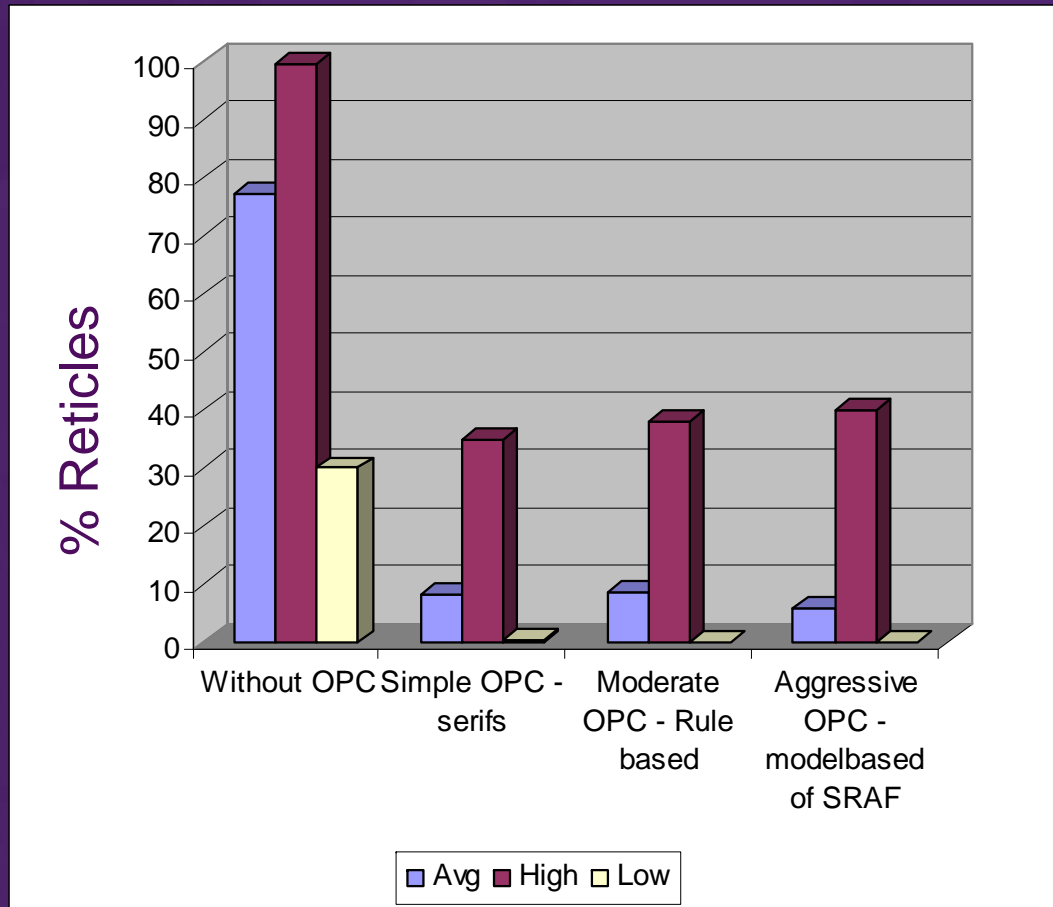
Outline

- Motivation for OASIS
- Implementation Overview
- Performance Results
- Flow Tuning Example
- Market Adoption
- Interoperability Concerns
- Moving beyond GDSII Limits

Top 2 Motivators

- 1) File size getting too large
- 2) Approaching GDSII 32-bit barrier

2004 Industry Assessment of OPC Use



- 10/13 mask makers world wide representing ~85% WW mask revenue (captive Mask Makers not represented)
- 77.1% (avg) use no OPC
- Leading edge users in the range of 35-40% OPC of varying aggressiveness
- Net: Use of OPC is user dependent

Source: BACUS 2004, Industry Mask Assessment, G. Sheldon / International Sematech

OPC Data Volume Increases

Input DB
Cells =
10795

Output DB
Cells =
337928

Hierarchical
Flattening **31X**



14 vertices



76 vertices

Dissection &
Correction **5X**

GDSII Coordinate Primer

Design Library Techfile

User Unit: 1.0um
Resolution: 0.001um



Design Entry

X = 10.15
Y = -12.45

(Grid Snap 0.05)

$$\times \frac{1.0\mu\text{m}}{0.001\mu\text{m}}$$



Layout DB

X = 10150
Y = -12450

32-bit Signed Integer

Byte 1	Byte 2	Byte 3	Byte 4	
01111111	11111111	11111111	11111111	= 2147483647
00000000	00000000	00100111	10100110	= 10150
00000000	00000000	00000000	00000001	= 1
00000000	00000000	00000000	00000000	= 0
11111111	11111111	11111111	11111111	= -1
11111111	11111111	11001111	01011110	= -12450
10000000	00000000	00000000	00000000	= -2147483648



Magnitude vs. Resolution vs. Origin

Chip Origin	Resolution	DBU's/μm	Max Chip Size (μm)
Center	0.001 (1.0nm)	1,000	2,147,482.000
LL	0.001 (1.0nm)	1,000	1,073,741.000
Center	0.0001 (0.1nm)	10,000	214,748.2000
LL	0.0001 (0.1nm)	10,000	107,374.1000
Center	0.00001 (0.01nm)	100,000	21,474.82000
LL	0.00001 (0.01nm)	100,000	10,737.41000

Fixed 32-bit Signed Integer



- As resolution increases, magnitude decreases
- Using a center origin enables larger design size

Real-life 32-bit Case Study

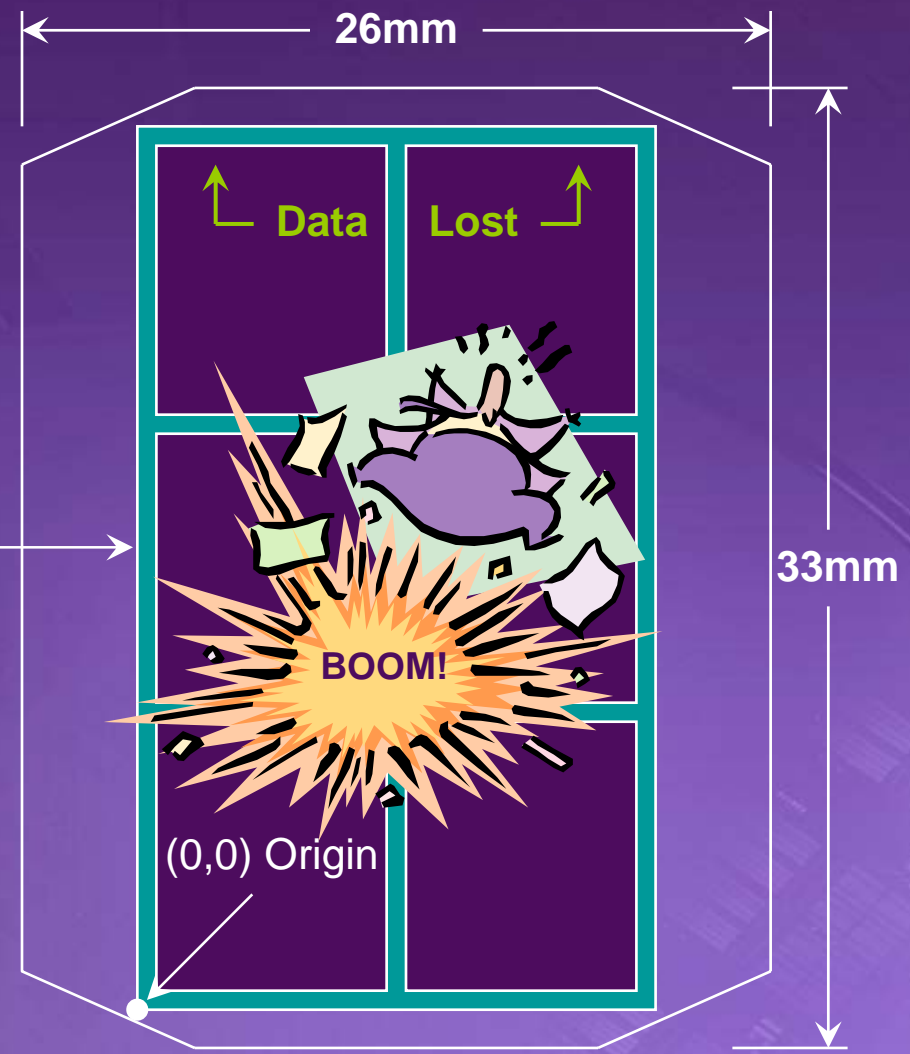
Modern Wafer Stepper Specifications

Wafer Size: 300mm
Reticle Size: 6 inch
Reduction Ratio: 4:1
1X Field Size: 26mm x 33mm

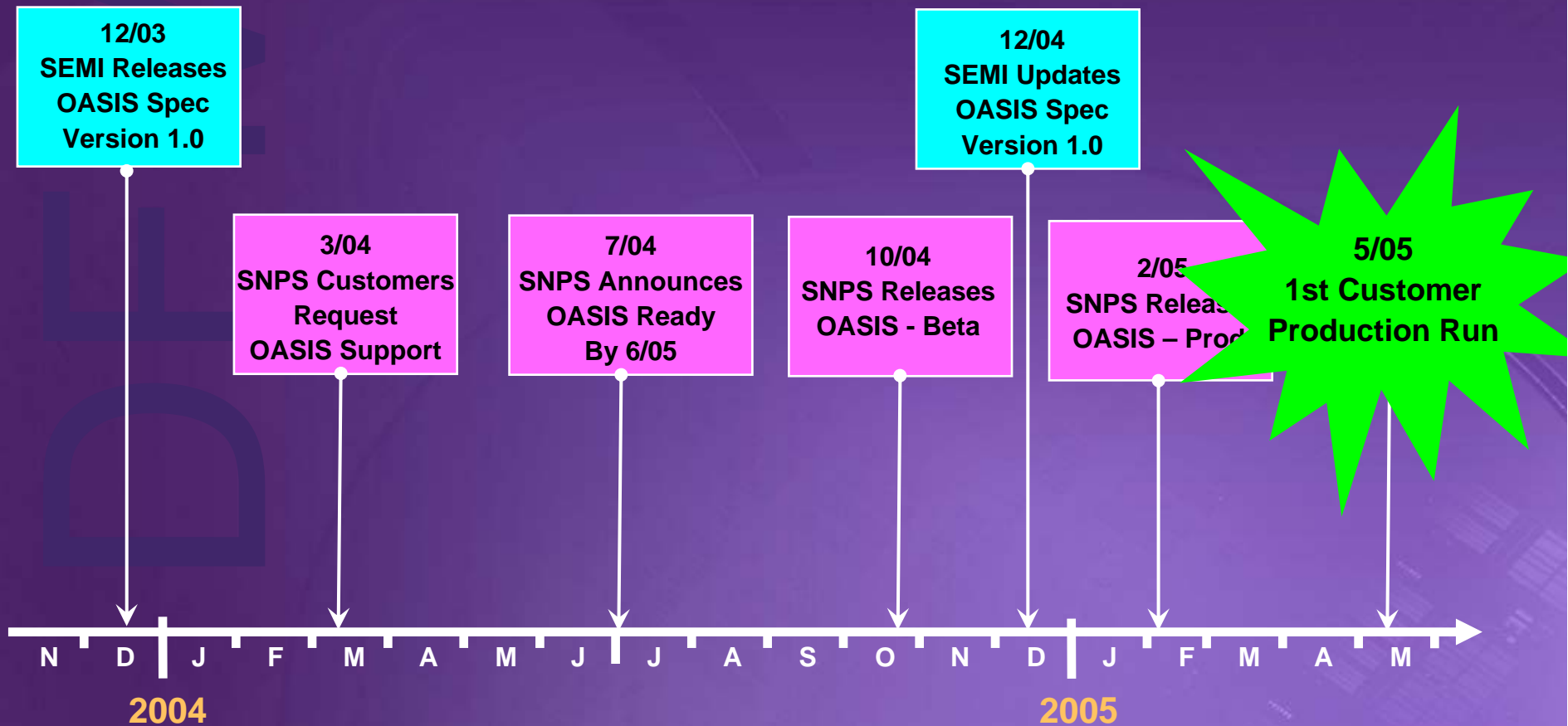
6 Die 1X Reticle Frame
Width: 18,000um
Height: 30,300um

Maximum Coordinate @ 0.1nm Resolution

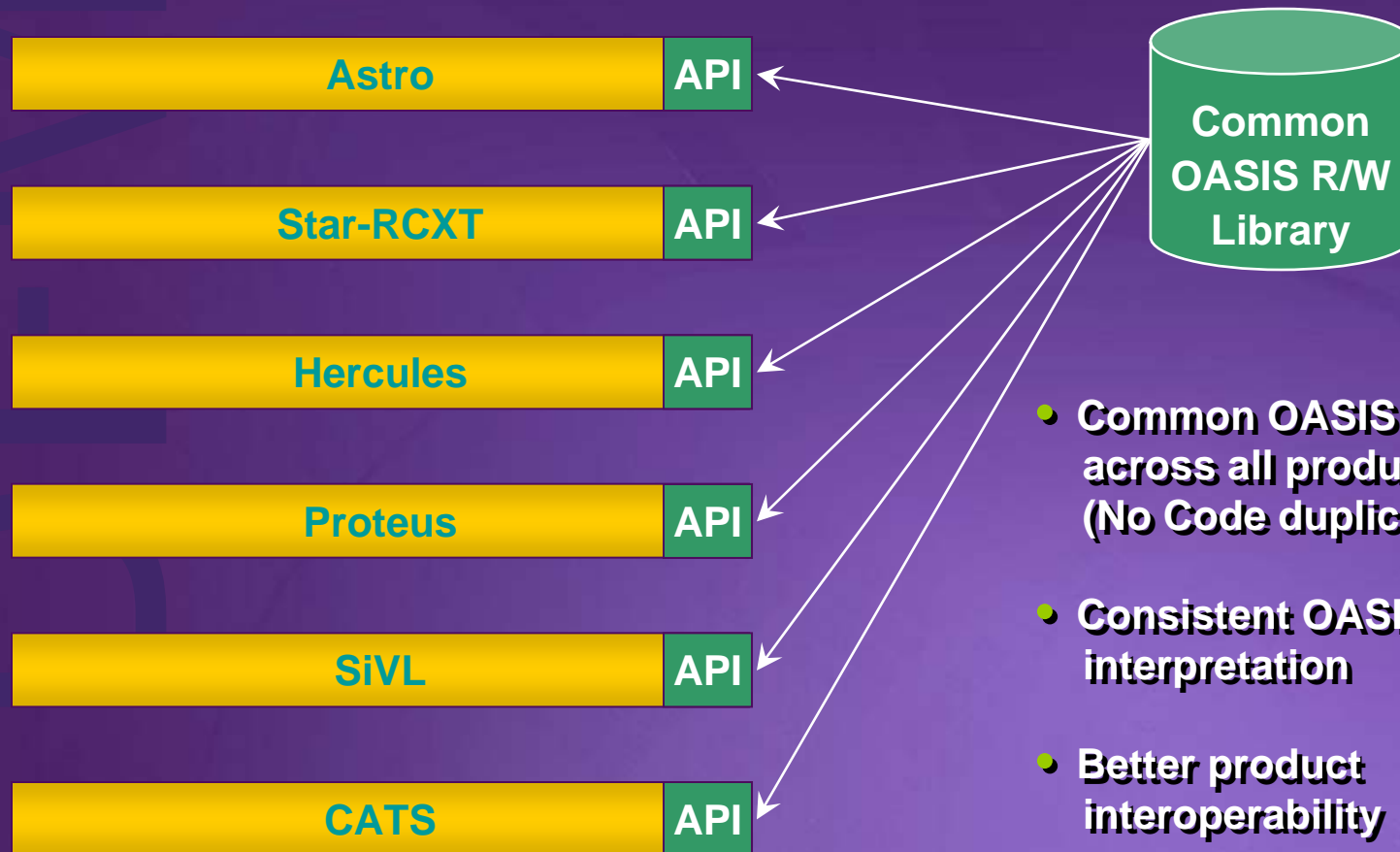
(2³¹) +214,748.3647um
(2³⁰) +107,374.1823um (Boolean 1 bit)
(2²⁸) **+26,843.5456um** (Merge 2 bits)
3 Overhead bits



Synopsys OASIS Timeline

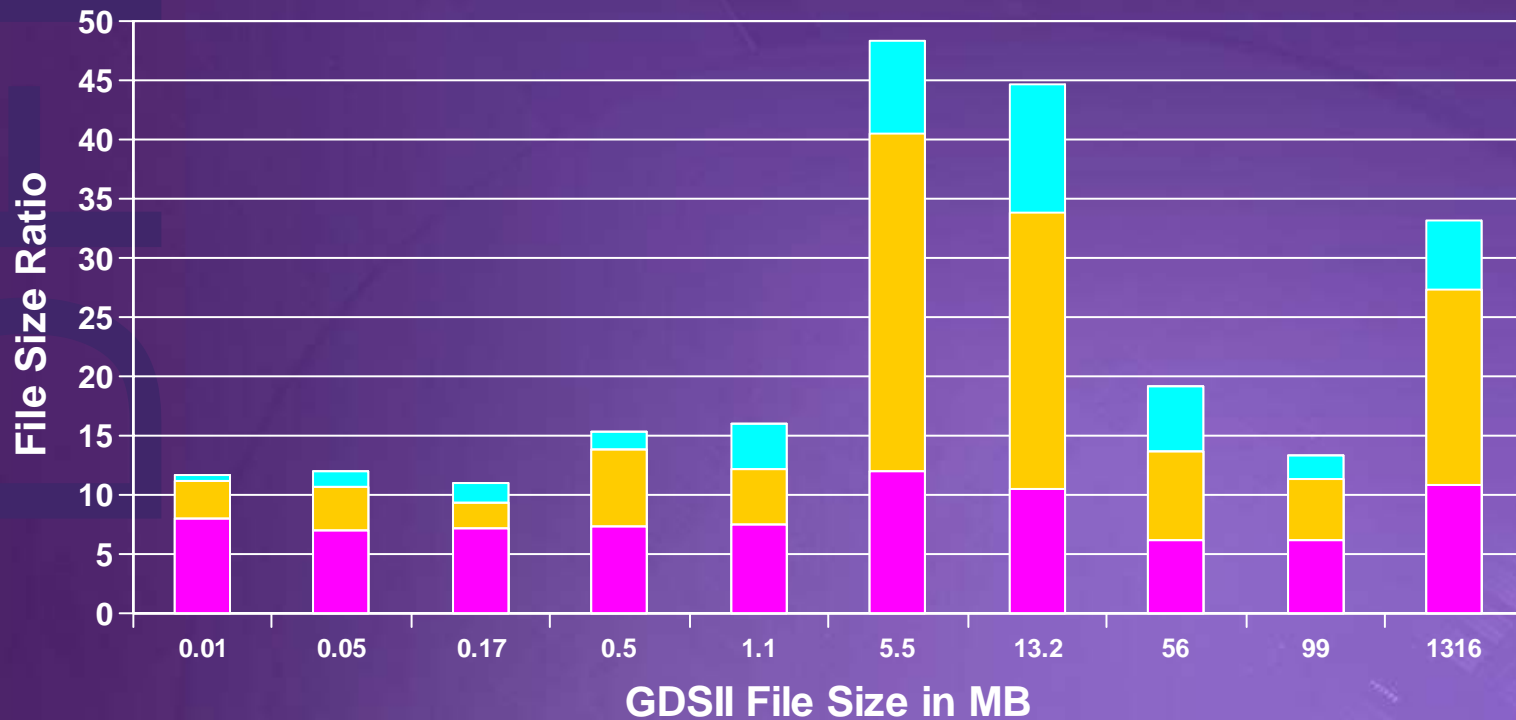


Synopsys OASIS API



GDSII vs. OASIS File Size Ratio

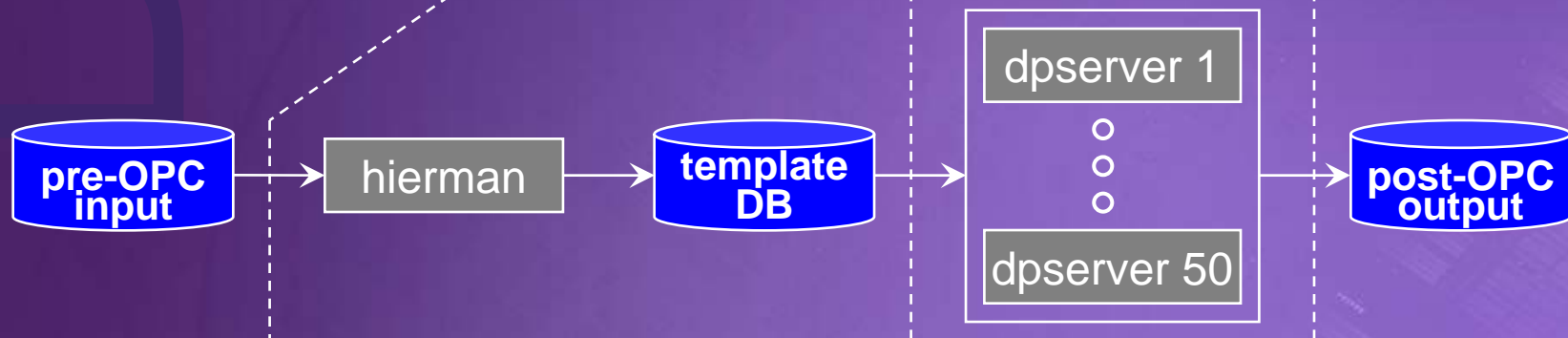
- No CBLOCK or Compaction
- CBLOCK Only
- CBLOCK w/ Compaction



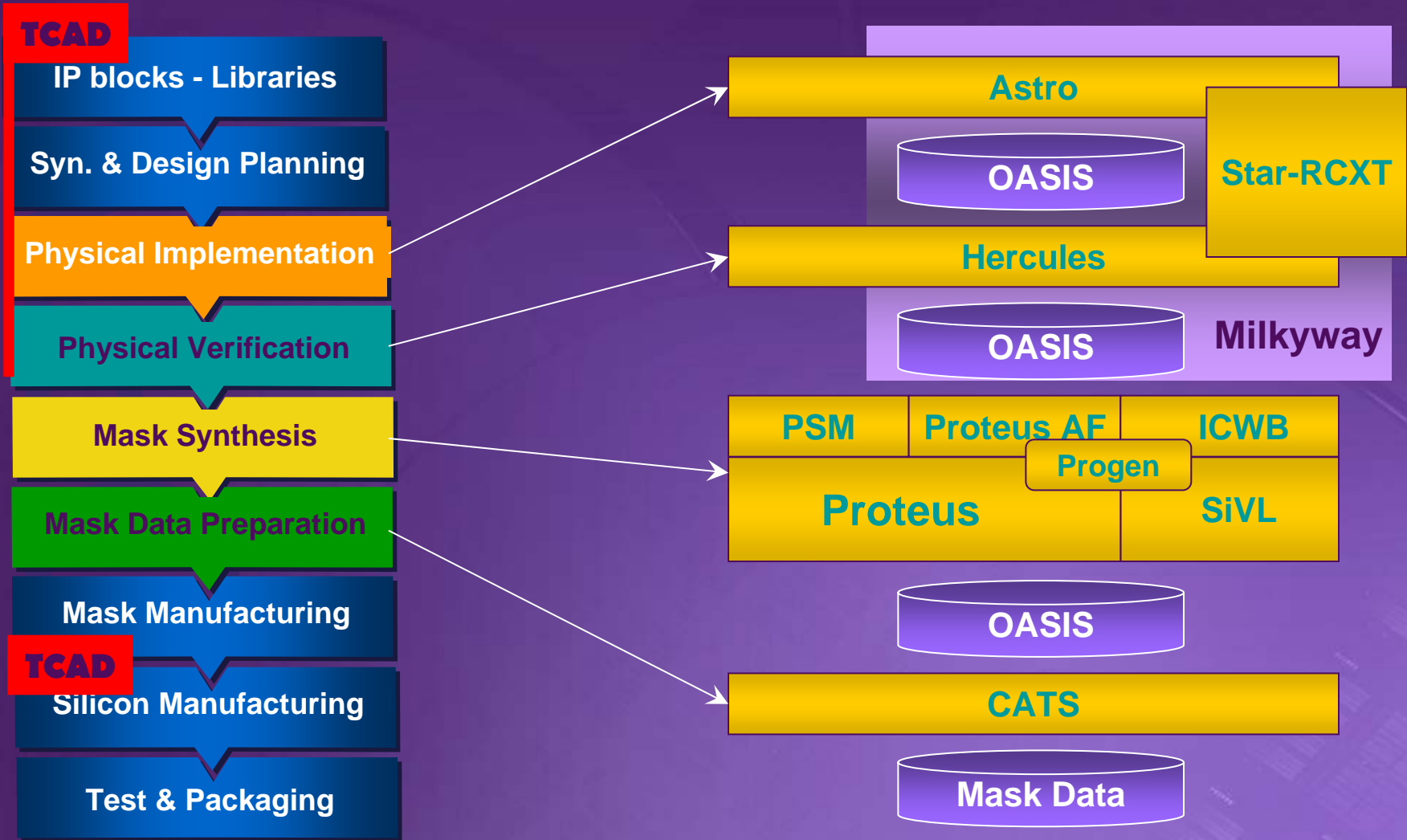
OASIS File Size Isn't Everything

GDSII vs. OASIS Proteus OPC Comparison (50 CPU's)

Format	Input		Hierman phase		Correction phase		Output
	File Size (MB)	Template Count	Memory (MB)	Memory (MB)	Total CPU Hours	File Size (MB)	
GDSII	1,300	395,039	5,875	5,784	221.4	26,392	
OASIS Compaction Style 1	76	515,304	2,144	2,127	221.5	2,649	
OASIS Compaction Style 2	82	337,927	2,111	2,084	215.6	2,745	



Synopsys DFM OASIS Flow



Missing CBLOCK Support

- Problem Description – Non-Synopsys application unable to read CBLOCK records in Synopsys OASIS files

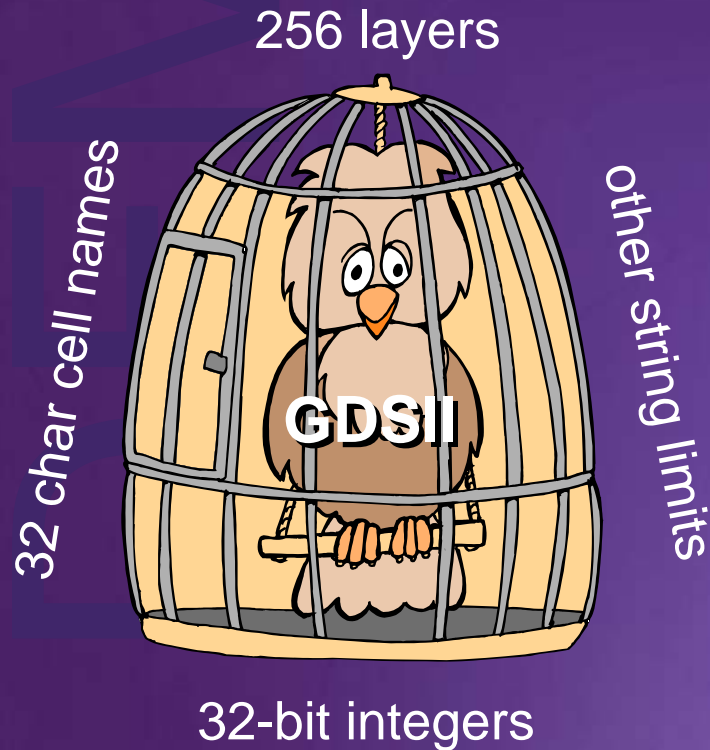
```
ERROR: Unknown record type in input file add4.oas at  
record offset 240
```

- Cause – Partial implementation
- Work-around – Use option to turn off OASIS compression in Synopsys application. Hercules example:

```
OASIS_OPTIONS { COMPRESSION_LEVEL = 0 }
```

- Solution – Request fixed product version from vendor

Moving Beyond GDSII Limits



- Even though OASIS is not constrained by the old GDSII limits, current EDA software still is
- It will take time for EDA tools to design out the old limits

DFM

SYNOPSYS®

Thank You.



> Your Design Partner

SYNOPSYS®