

**DNP**

# Photomask issues for 45-32nm

20<sup>th</sup> June, 2005

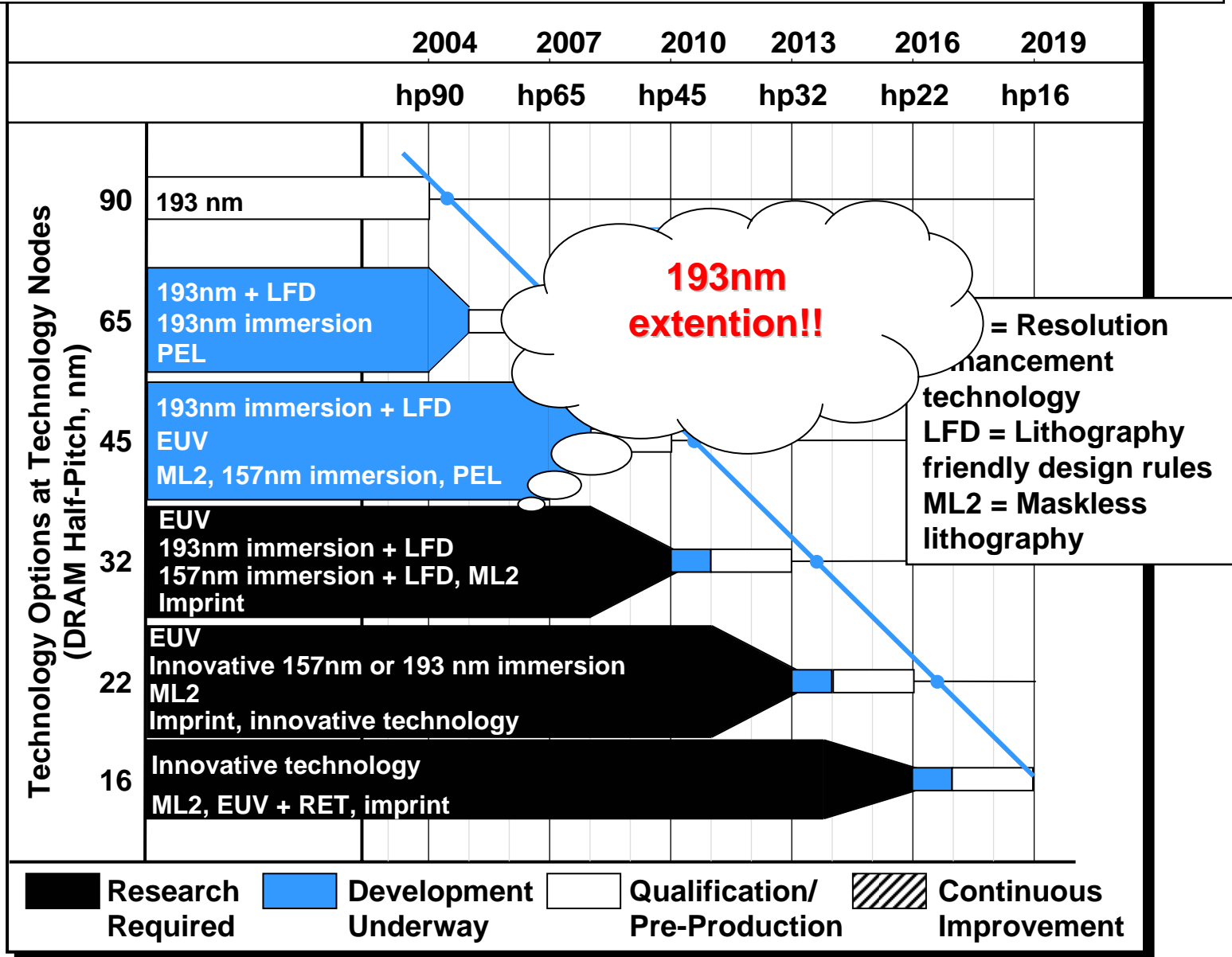
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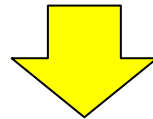
# Lithography Potential Solutions in 2004 Update



- Hyper NA Lithography – New Challenge!?
  - ✓ Fewer material challenges than 157nm
- RET Options?

NA	65nm-hp	45nm-hp	32nm-hp
0.85	0.286	0.198	0.141
0.92	0.310	0.215	0.153
1.00	0.337	0.233	0.166
1.20	0.404	0.280	0.199
1.44	0.485	0.336	0.239

$\lambda=193\text{nm}$

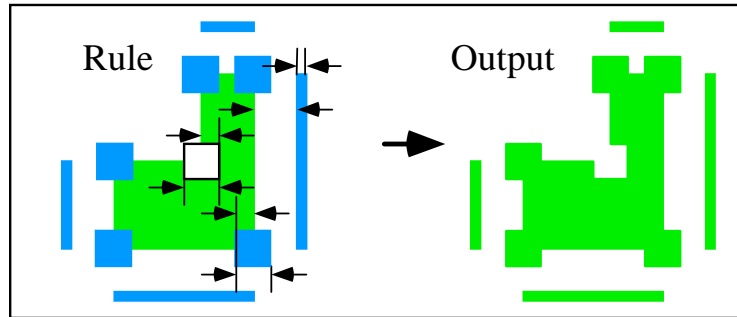
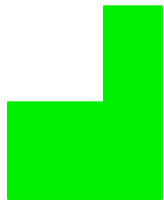


- ✓ Hyper NA lithography with low  $k_1$
- ✓ Strong RET requirement will increase

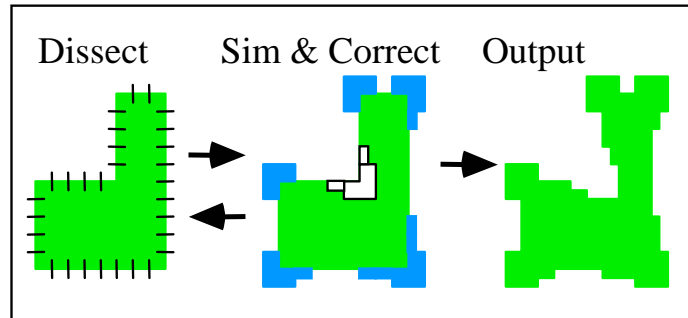
# OPC!!

## Rule Base OPC

Original

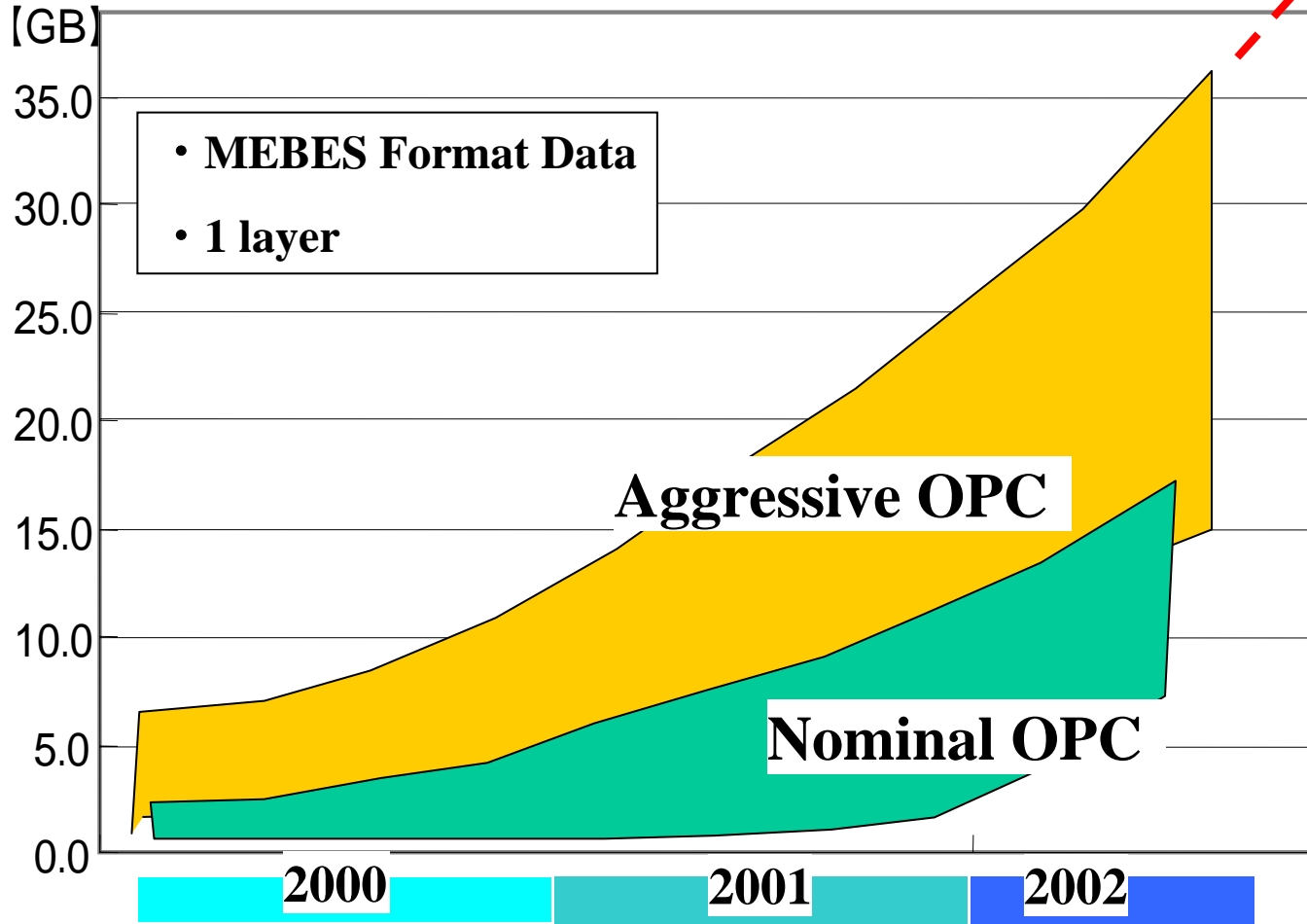


## Model Base OPC



# Data volume with OPC

>>100GB?!

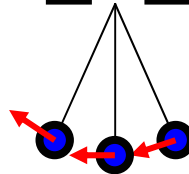
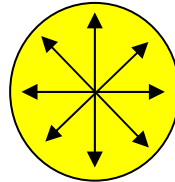


# Polarization related issue on photomask

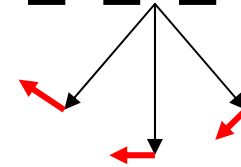
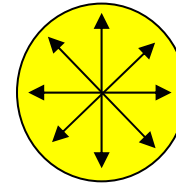
Smaller pattern pitch will make...

- Polarization effect

@65nm HP



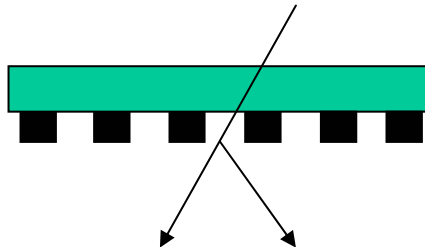
@45nm HP



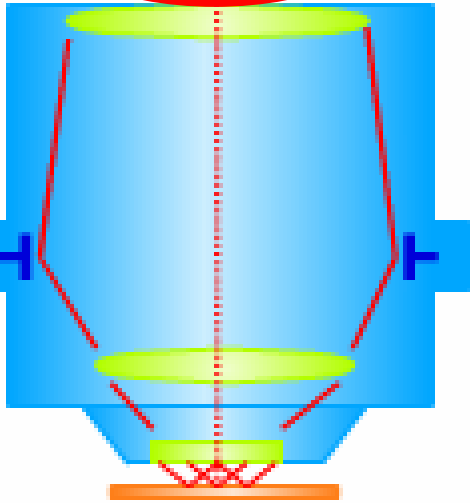
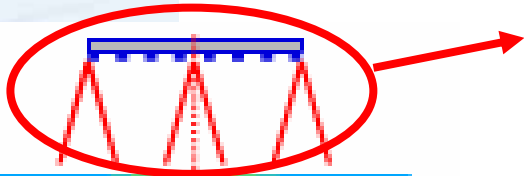
Lower contrast with TM

- Topography effect

Angled illumination of Hyper NA scanner

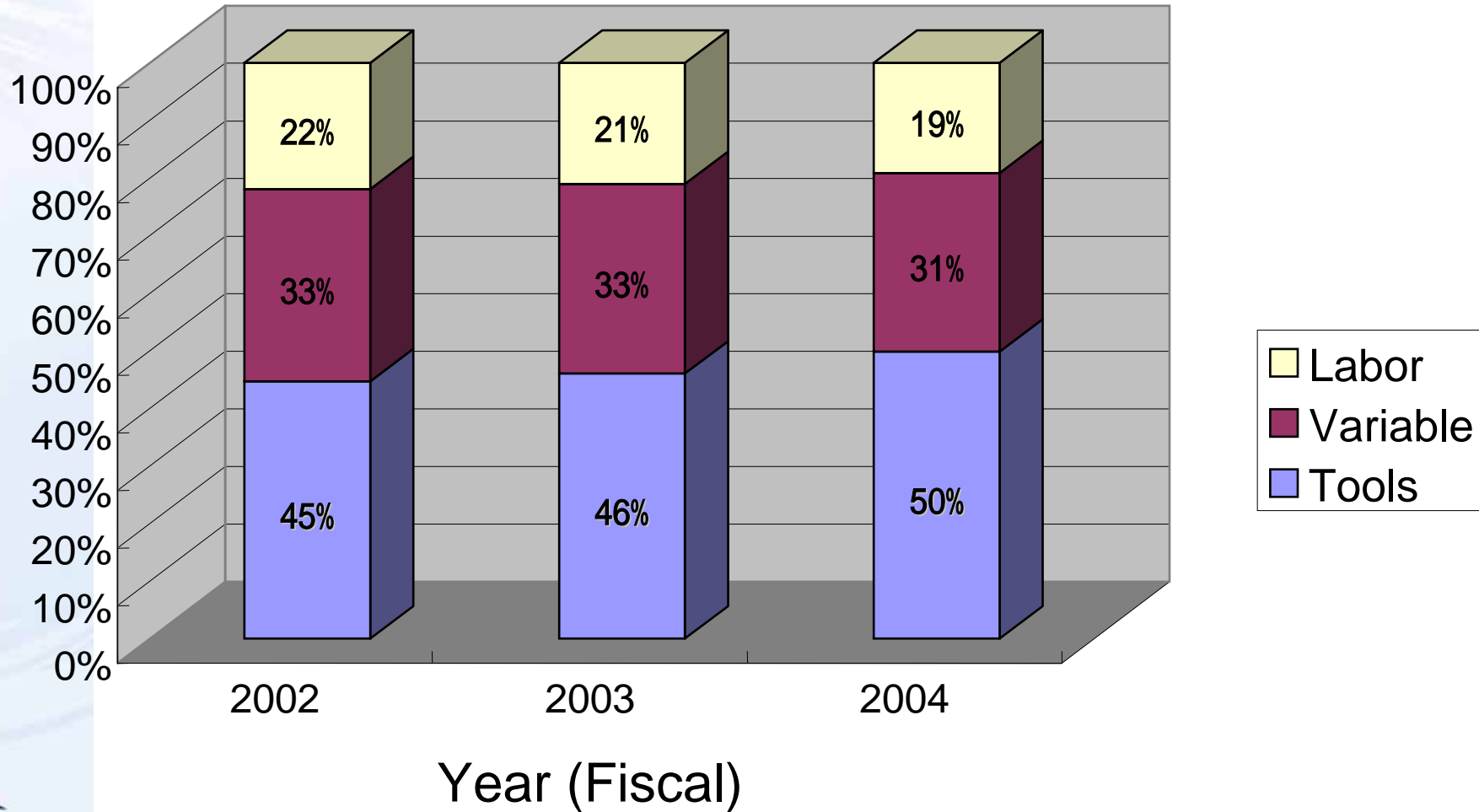


Shadowing effect



- **Mask Cost**

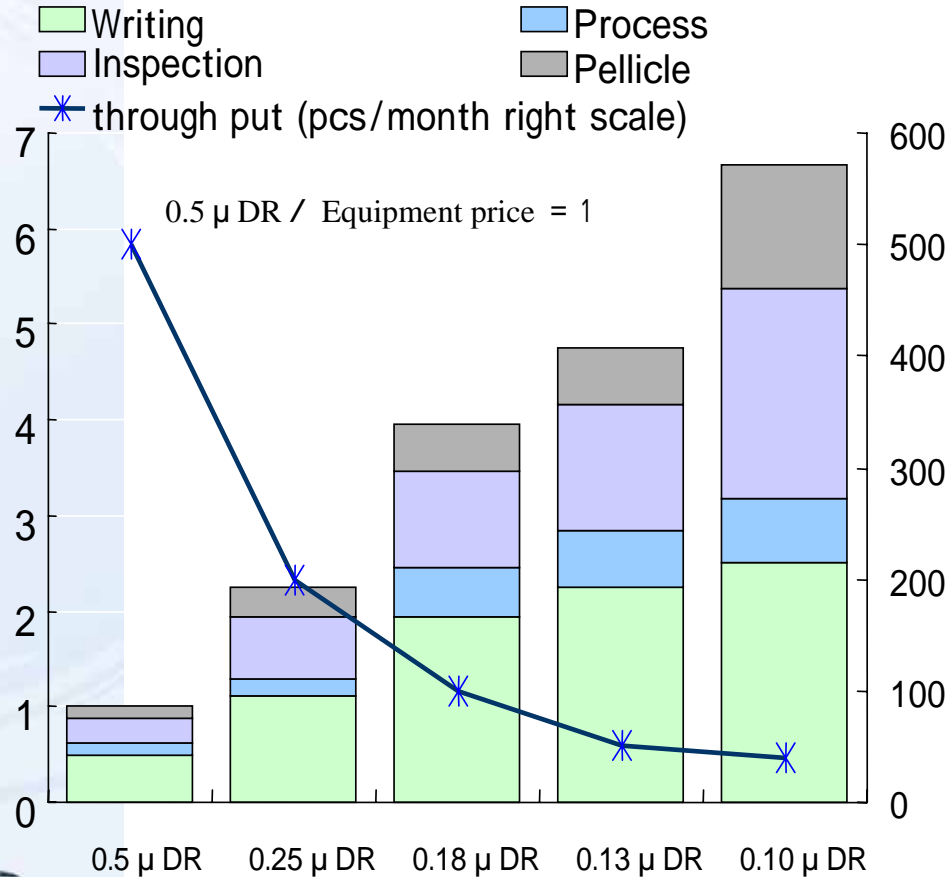
# Production Cost



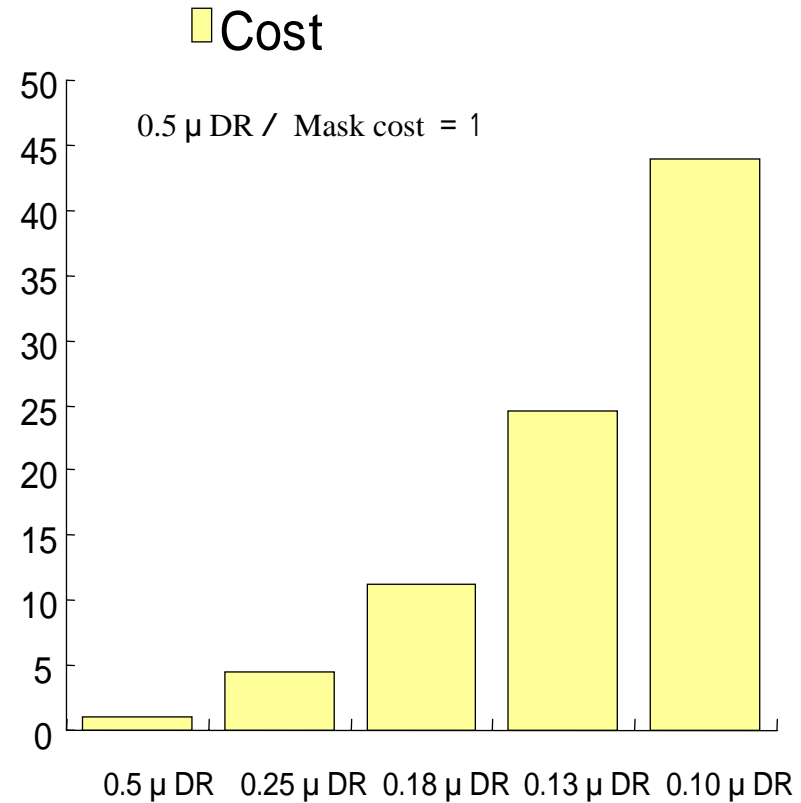


# Trend of Equipment Cost Model

Trend of Equipment Price



Trend of Equipment Cost in Mask Manufacturing



# How to reduce the mask TAT & cost?

1. Minimum Data Handling
  - Optimized OPCed data preparation (No OPC on characters in chips, please!)
  - Standardized data format (OASIS, P-10, etc.)
  - Data handling For mask Manufacturability (DFM!)
2. Improve Tool Productivity and Cost
  - Writing Tool, Inspection Tool, Repair Tool, ...
  - Collaboration for infrastructure development
3. Optimize Total Lithography Cost
  - Multi products and/or multi layers on mask
  - Increase your products volume!