DATA MANAGEMENT

ONE SIZE DOES NOT FIT ALL

DATA MANAGEMENT FOR THE SEMICONDUCTOR IC CHIP MANUFACTURING PIPELINE

Data Management is critical when we are collecting and transforming different data types from different manufacturing processes and converting them to improve semiconductor yield, quality, and reliability in the supply chain.

Over the years, improved semiconductor integration precision has resulted in enormous data handling demands on processes that involve writing circuit pattern data onto the masks and chips.

Situation:

Our client is a manufacturer of complex equipment for the manufacture of semiconductor devices among them the photomask mask writer. Mask writers used in semiconductor photomask manufacturing use complex systems that machinate precision geometry at the nanotechnology level, process enormous amounts of data at the 'tera' scale, and also involve high precision and speed information processing technology. The circuit design printed onto the photomask and chips must go through various stages of data management involving conversion and validation to be in an acceptable format for input to the electron beam mask writer.

Objective:

Our client needed a set of designed, tested, and deployed data management systems to operationalize the mask writer for their end stakeholders.

The mask writer needs data in binary machine format to be able to write the CAD design data onto the photomask. This needs to be generated using a sequence of Data Converter Tools. The circuit pattern for the design is initially written in human readable ASCII or similar language. The first Data Converter Tool converts this to a geometric pattern mapping representative of

technology mapping which indicates the geometric position of the hardware components on the mask. The proprietary input CAD binary data is converted to other binary formats and finally to Short Data Format (SDF) which is the end format accepted by the mask writer.

The information to be handled must be precise at the terabyte level with high speed and precision requiring deep domain expertise in designing of algorithms that convert, test, validate and store user generated CAD Design data to machine readable data.

The objectives of the project were to design, develop, test, and deploy as follows:

Data Converter for Mask Writer

Data Generator

Data Dump Tool

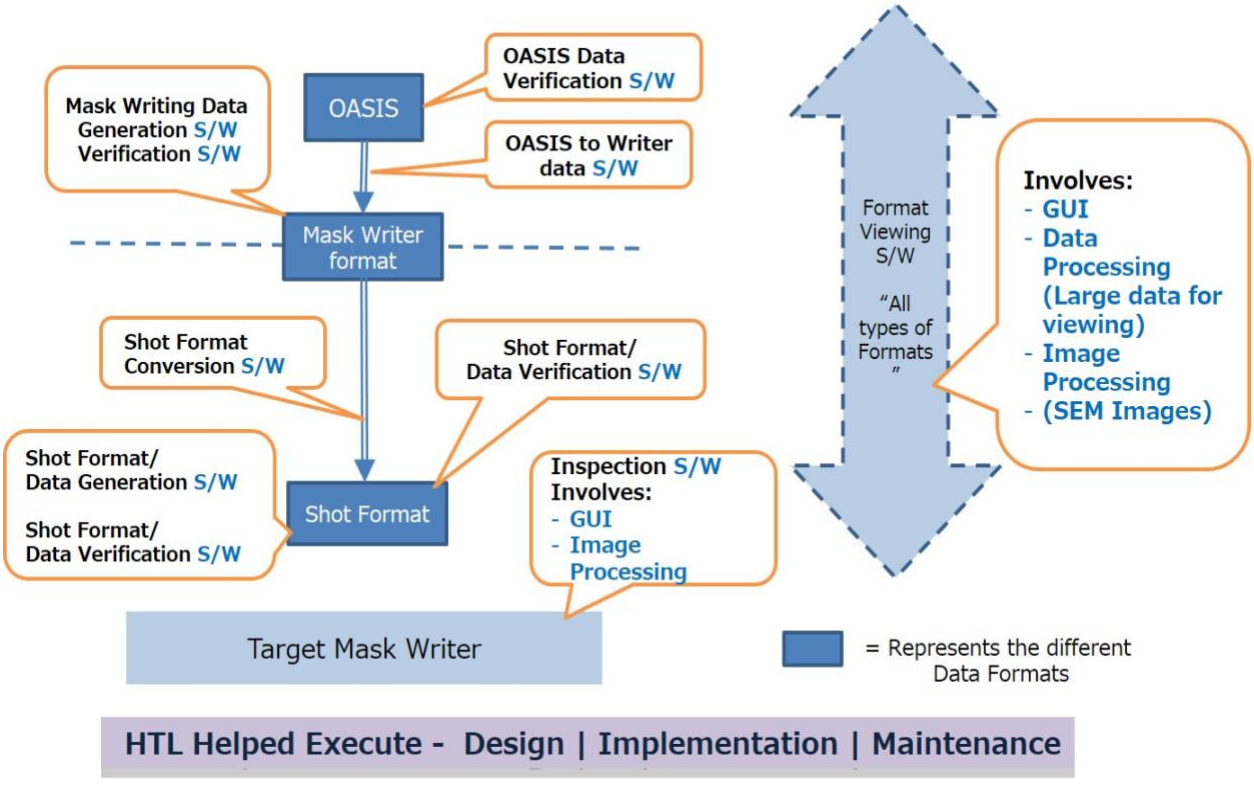
Data Checker

Data Library

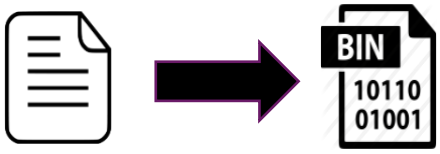
Data Viewer Dashboard

Solution:

The solution was designed and developed in different modules to meet the various needs:



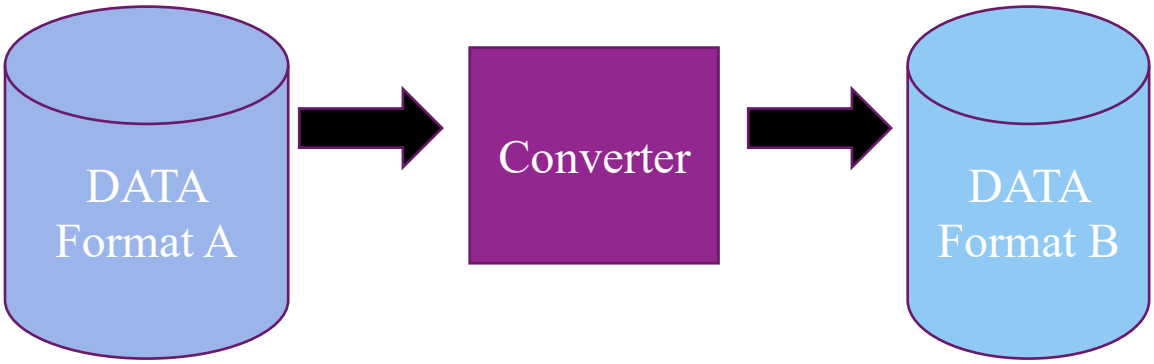
DATA GENERATOR



This software generates proprietary binary data from ASCII text file and is one of the first steps.

- Mask Writer proprietary format Data Generator

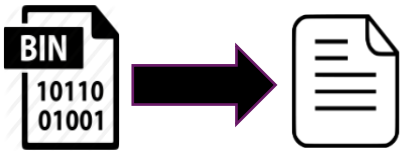
DATA CONVERTER FOR MASK WRITER



This software converts proprietary input binary data format to another proprietary binary format like:

- OASIS to Mask Writer proprietary Format B Converter
- Format B to PDG Converter
- Format B to SDF Converter

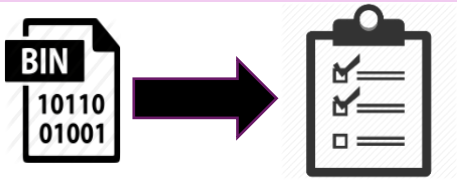
DATA DUMP TOOL



This software generates ASCII text file from proprietary binary data format. This process helps in validation and testing of results.

- Proprietary format B Dump Tool
- Format C Dump Tool

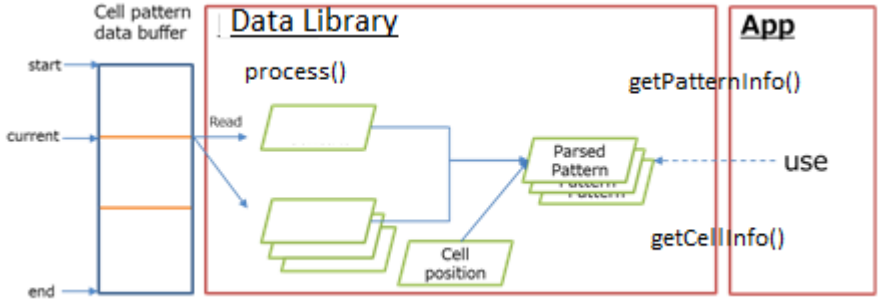
DATA CHECKER



This software helps check and validate proprietary binary data formats.

- Format B Data Checker
- SDF Data Checker
- OASIS Data Checker

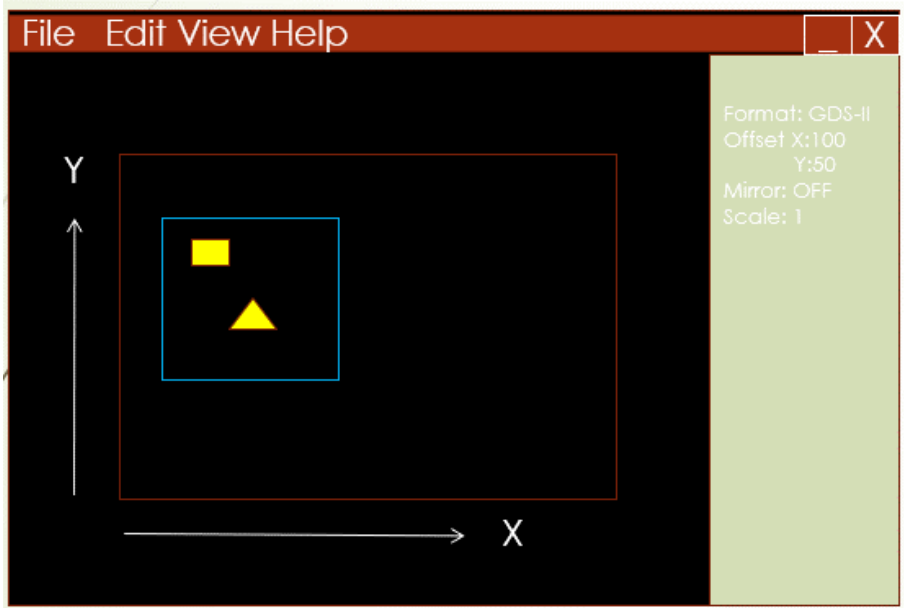
DATA LIBRARY



This software reads proprietary binary data format and provides API gateways for accessing different information within the data.

- Format B Data Library
- Format C Data Library

DATA VIEWER



Through this software, user can open different mask data formats. It performs different viewing actions

- View
- Zoom in & out
- Scaling
- Mirroring
- Navigate

Through this software, users can verify actual SEM image and binary data format.

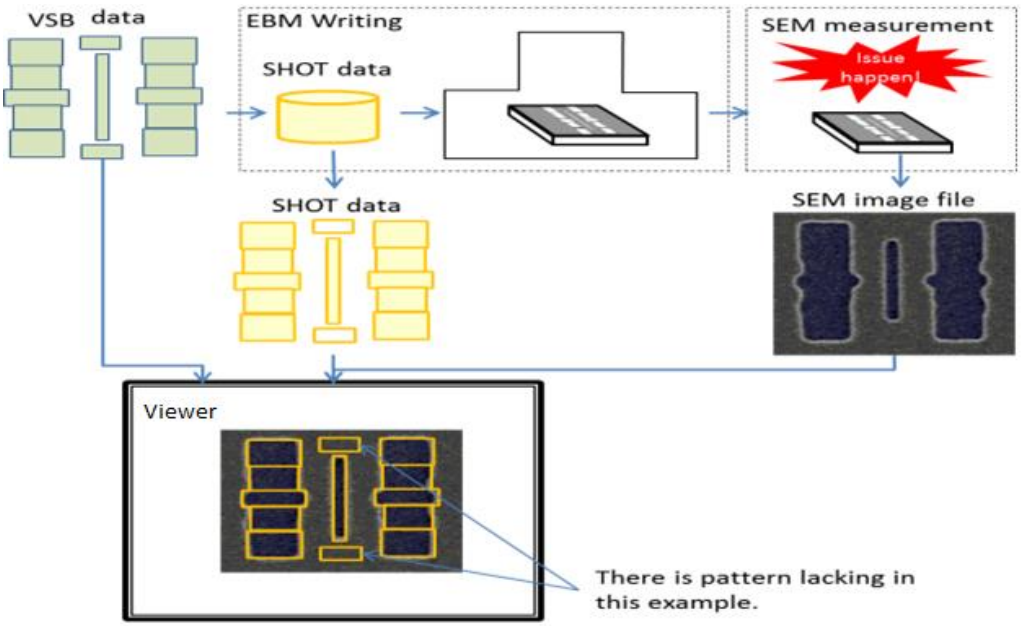
CHALLENGES FACED

- Understanding different Data Formats
- Handling Big Data
- Multithreading for Process Optimization
- View time optimization using different pixel-based optimization and internal algorithm.

TECHNOLOGY USED

- Linux Operating System
- GCC Compiler
- C, C++, Tcl,Shell scripts
- Image processing using OpenCV

The figure below illustrates the schematic workflow of data conversion to SHOT Format and electron beam writing and Verification on viewer dashboard of VSB Binary data format comparison after scanning with scanning electron microscope (SEM) image.



DEFINITIONS, ACRONYMS AND ABBREVIATIONS

OASIS	**O**pen **A**rtwork **S**ystem **I**nterchange **S**tandard
SDF	**S**hort **D**ata **F**ormat
GIMP	**G**NU **I**mage **M**anipulation **P**rogram
GTK	**G**IMP **T**ool **K**it
SDLC	**S**oftware **D**evelopment **L**ife **C**ycle

Result:

The volume of figure design data needed to describe the circuit patterns is comparable to the data volume of the latest HDD. The writer beam deflection controls can receive all the figure data without a single miss of order all within a couple of hours. This enables the mask writer with its cutting-edge processors to be able to parallel process large volumes of terabyte data with ultimate reliable data management algorithms and systems that enable writing one trillion figures without a single error. With the support from HTL, our client is well prepared to handle future increases in data volumes and processing to meet market demands for their machines.