



Intel Mask Shop Automation

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★ Overview of Intel Mask Shop Automation

★ Entity Interaction Characteristics

- ☞ Design Data

- ☞ Equipment

- ☞ Handling

★ Automation examples

- ☞ Design data

- ☞ Metrology

- ☞ Defect Management & Disposition

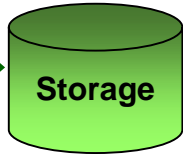
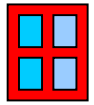
★ Summary



Mask Shop Automation

Industry Standards + Current and Future Capabilities

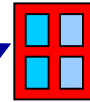
Fractured Mask Data Set
XFR, Archive, Retrieve
In Less than 4 hrs



OASIS Data format for Fracture Data
SEMI P10 & XML standards

100% automation In-House for
Tool/Vendor Specific Formats
For Write, Inspection, Metrology

To Wafer Fab



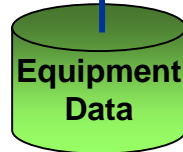
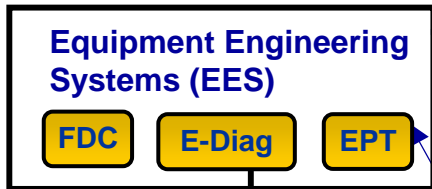
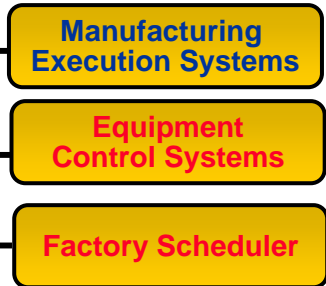
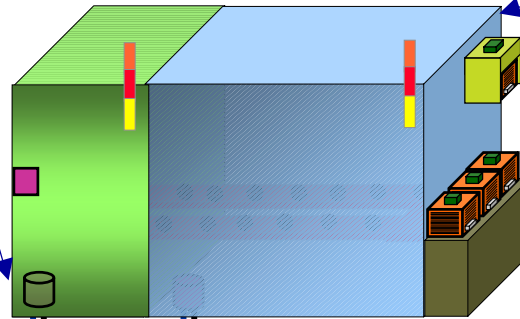
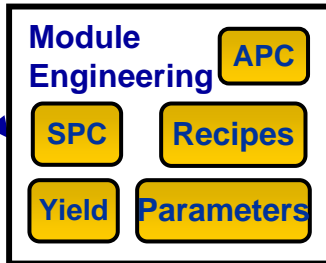
Mask In Compact
Identifiable &
Traceable through
RFID Initiative

Full Content Recipe and
Parameter Downloads to
equipment

Data Format & Job Deck Standards
To support Fungible Mask Writing
And Inspection implemented by Tool
Vendors

Mask, Blanks ID &
Traceability enabled in
Tools and WIP Rack

MES Highly Customized to
minimize Manual
Processing



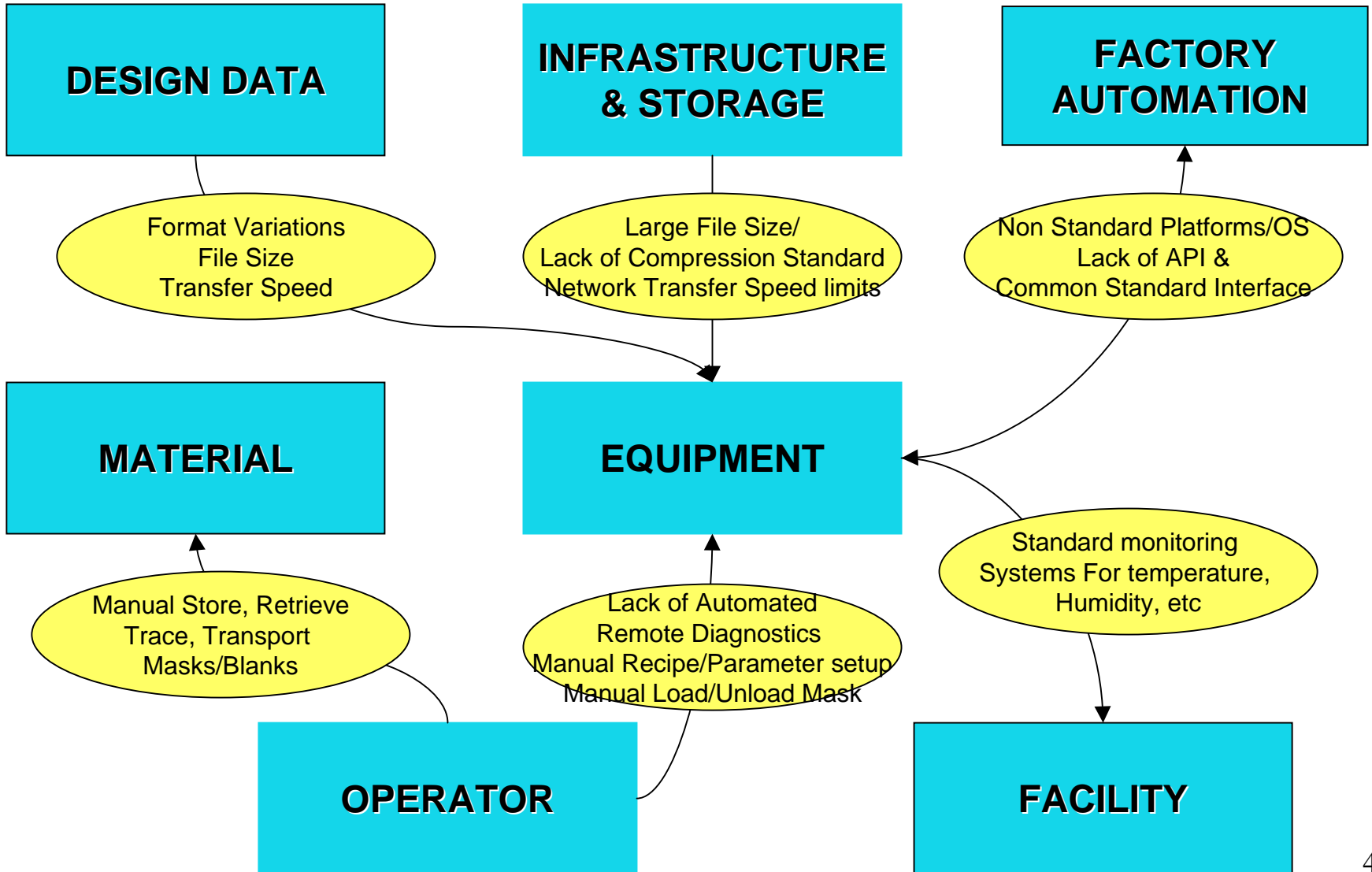
Equipment Data
Acquisition (EDA) to
support FDC and APC
needs

No manual intervention for
normal operational
scenarios.

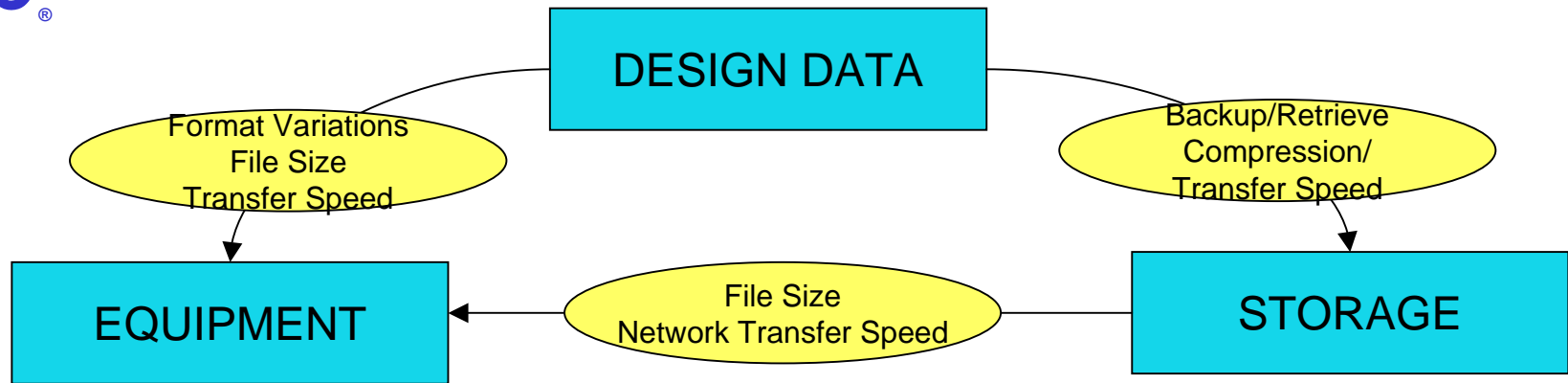
Equipment utilization
tracked via reported
states In Equipment Logs
through home grown
programs

Partner, Customer
Or Supplier

Entity Interaction Characteristics



Design Data



★ Issue: Storage, back-up and retrieve

- ☞ Current Status: Pattern data management system implemented working with several building block suppliers. (Veritas, ATL, NetAPPS, Cisco, Microsoft). Issue is complicated by the data sizes and the storage schemes for the various formats.
- ☞ Future: Engage building block Suppliers on roadmaps to support ever increasing data size, and to standardize on storage scheme and interoperability.

★ Issue: File transfer & large file sizes

- ☞ Current Status:– Implemented internal high speed networks, optimized flow to minimize transfers. Working with suppliers on simultaneous Compression & Transfer.
- ☞ Future: Moving to OASIS data format for next generation for 45 nm node.

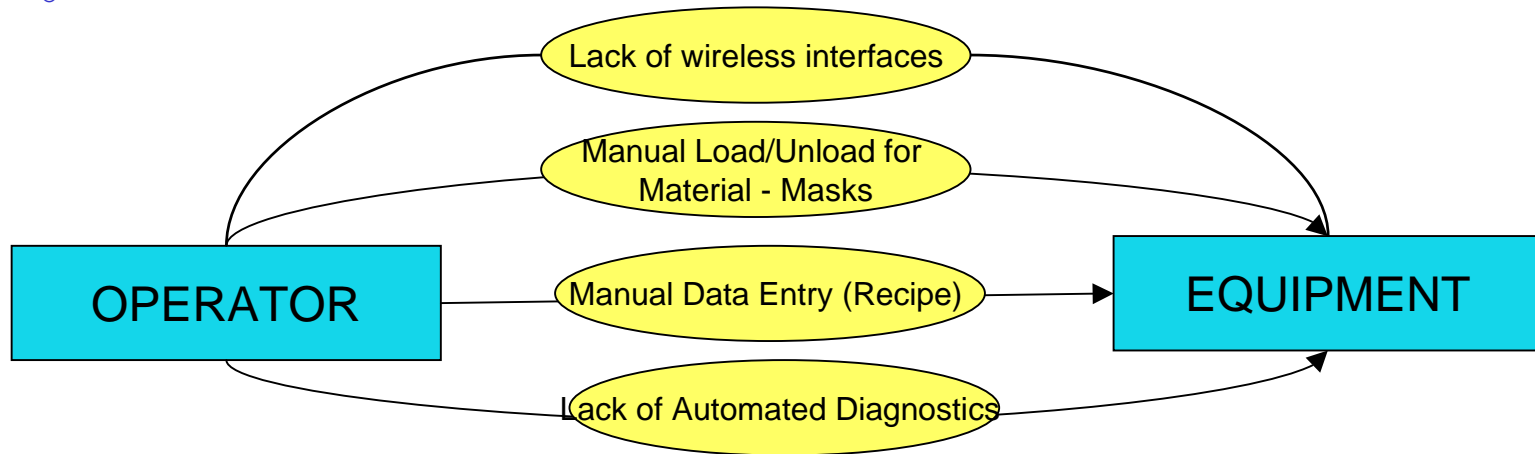
★ Issue: Non standard data formats require point solutions for data conversions

- ☞ Current Status: Implemented write tool specific conversion automation for MEBES, CFLT, VSB11, VSB12 etc.
- ☞ Future: Standardize the tool data formats by 45 nm node tool set.

★ Issue: Developing different software modules to handle the various Job deck formats and equipment control data formats

- ☞ Current Status: IMO is using XML as the internal format for standardization. Would help if the suppliers moved in this direction.
- ☞ Future: Standardize the tool Jobdeck/control data formats by 45 nm node tool set.

Equipment



- ★ **Issue: Most Mask equipment do not support standard interfaces. Poses issue for automation of Recipe Upload, Parameter down load etc.**

- ☞ **Current Status: We have developed solutions that are tailored to individual equipment where ever possible.**
- ☞ **Future: Encourage Suppliers to Implement standards in interfaces for all Mask Tools, Support data formats such as XML and API.**

- ★ **Issue: Many Mask tools do not support capability that enables remote diagnostics.**

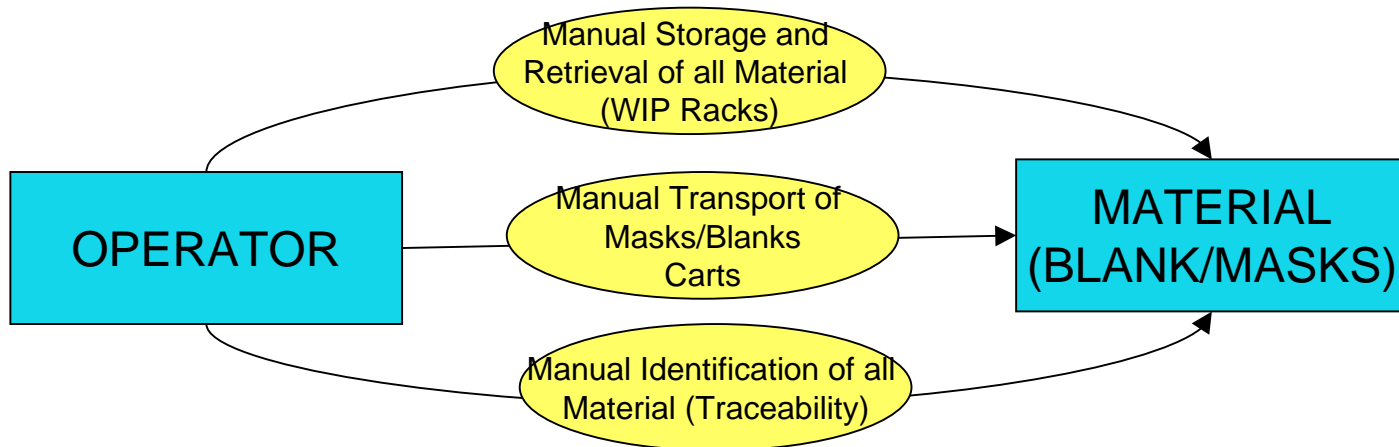
- ☞ **Current Status: We have implemented solutions for some tools suppliers to be able to access tools through the firewall for troubleshooting and diagnostics.**
- ☞ **Future: Require standards that will enable this key capability and support from tool suppliers to add layers that will enable remote access/debug on tools.**

- ★ **Issue: Many Tools do not support Fault detection & Classification or automated process control capability.**

- ☞ **Current Status: We do not have capability currently for factory wide monitor systems. Implementing point solutions currently where feasible.**
- ☞ **Future: Need for standards and capability on tools.**

Standardization of Equipment Interfaces

Handling



★ **Issue: Storage, Retrieval and Traceability of Mask and Identification of Pre-exposure blanks.**

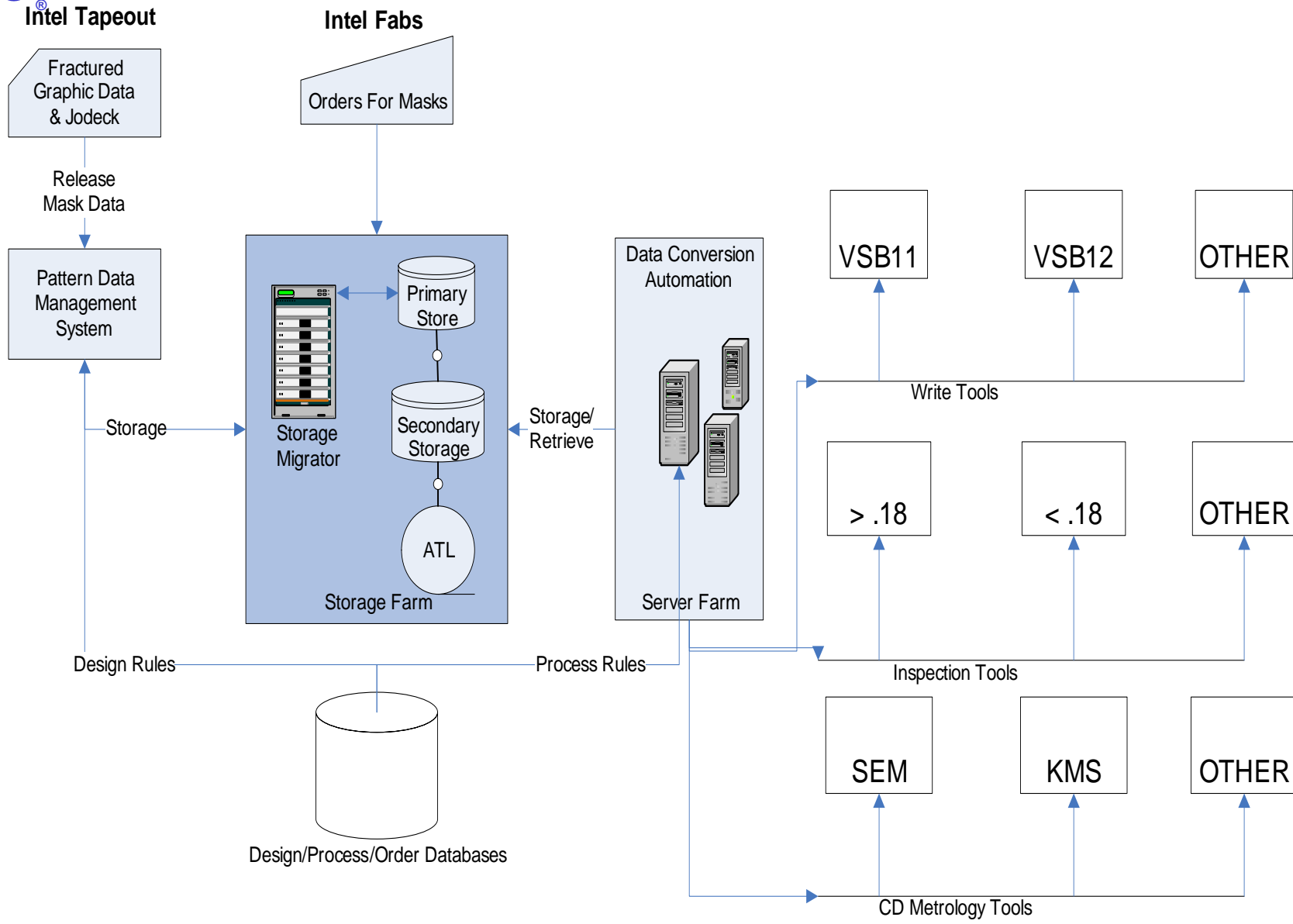
☞ **Current Status: Storage is mostly manual, Traceability has been addressed through use of RFID on compacts. Identification is still an issue.**

☞ **Future: Need capability and standards for blanks identification**

Some Examples of Intel Automation



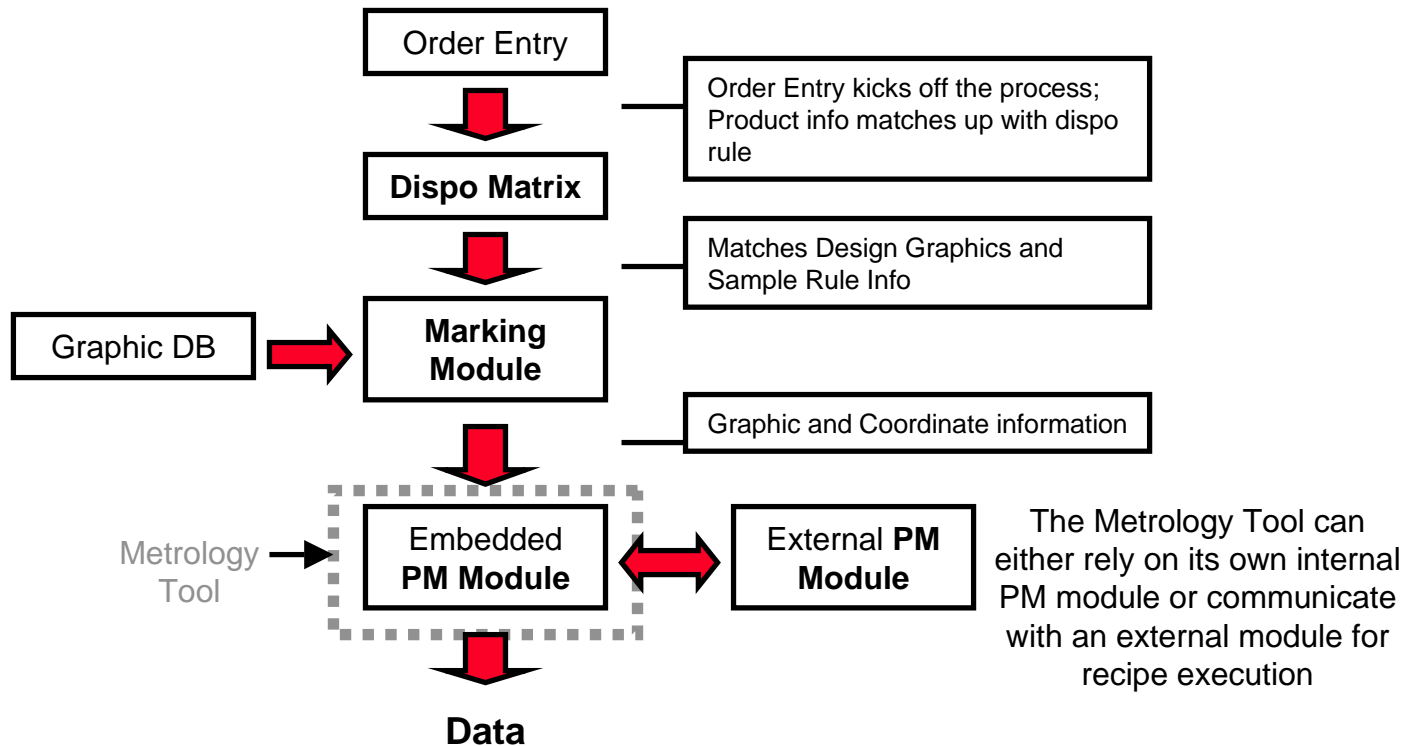
Design Data Automation



CD Metrology Automation

★ The key components to CD Metrology Automation are:

- ☞ Disposition Rule Matrix to provide the statistics-based foundation for sample rule generation;
- ☞ Marking Module as an engine to generate the “recipes” for Metrology tool;
- ☞ Pattern Matching module to interpret the images collected by the Metrology tool for receipt execution.



Defect Management & Disposition

Problem Statement

- 'Perfect' masks must be shipped.
- Every defect must be found, dispositioned, and repaired if lithographically significant.
- Defects need to be tracked/managed.

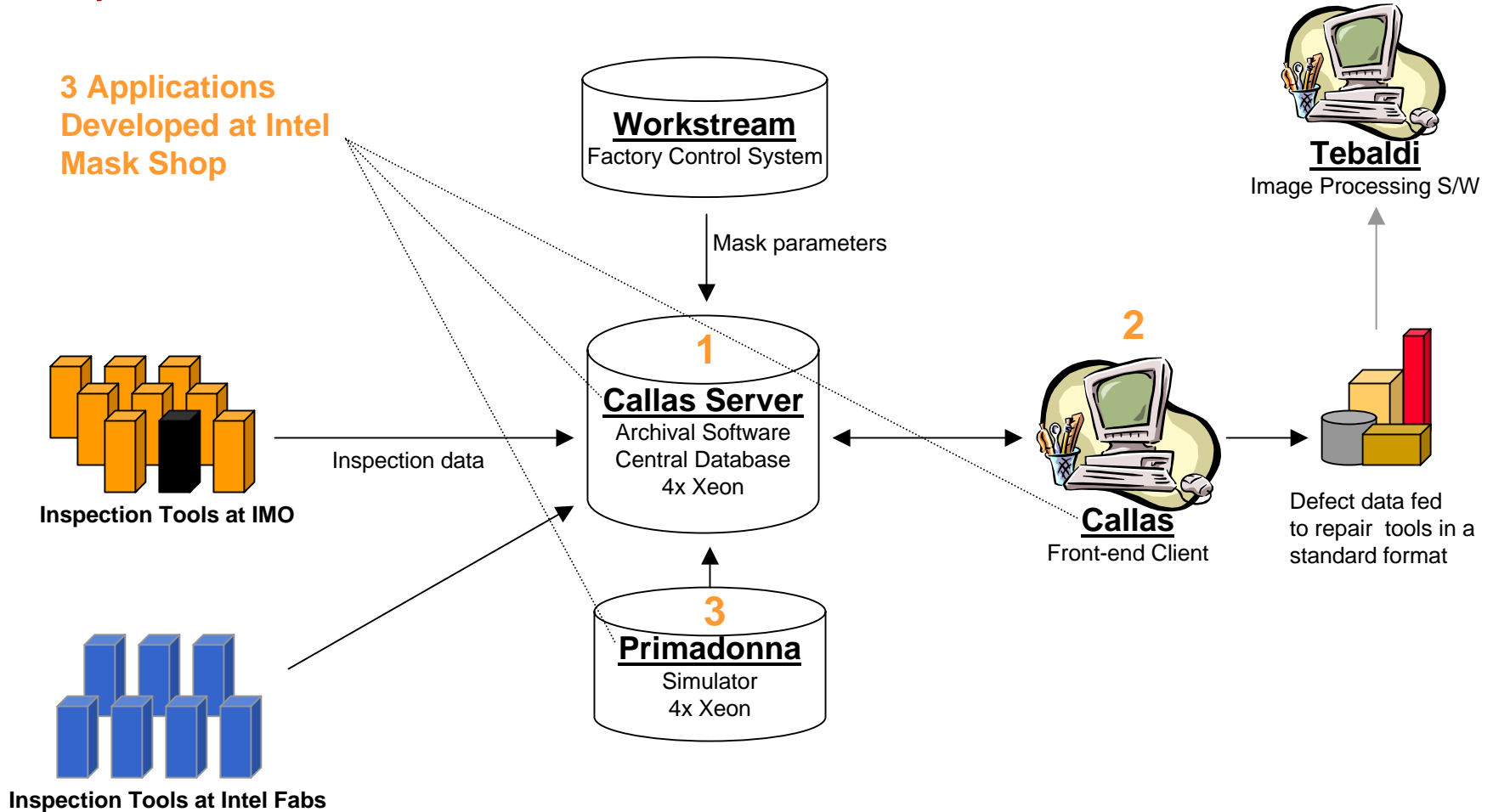
Solution:

- Build an in-house mask defect management and defect dispositioning system

Defect Management & Disposition

System Overview

3 Applications
Developed at Intel
Mask Shop



Disposition System

★ Goal:

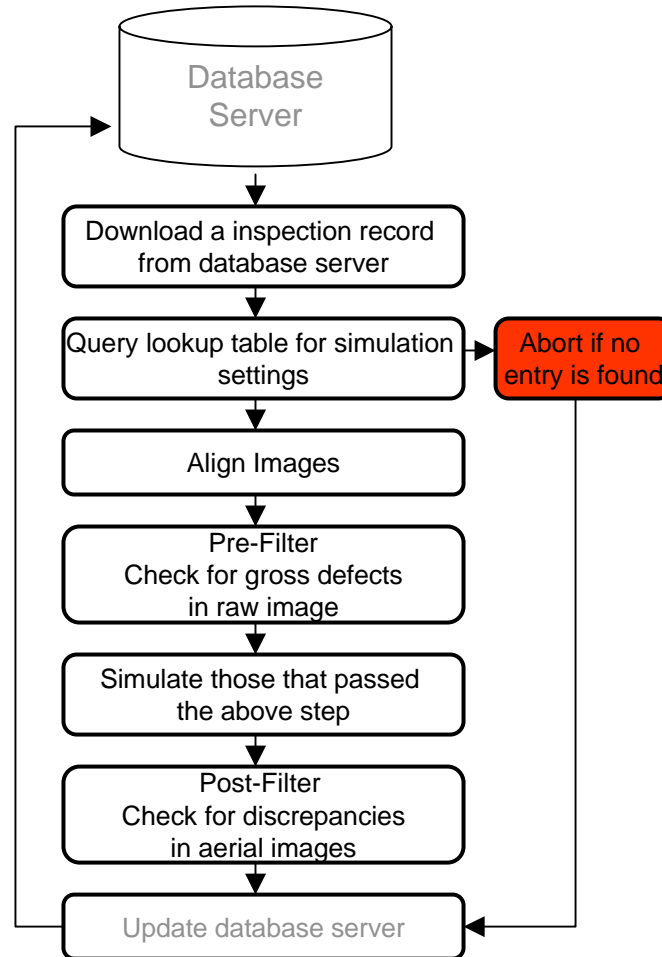
- ☞ Repair only what prints on the wafer

★ Features:

- ☞ Automatic dispositioning of defects
 - Gross comparison of defect and reference images
 - Aerial image simulation of defect and reference images
 - Automatic computation of critical dimensions
 - Fully automated

Defect Management & Disposition

Disposition System (Basic Steps):



System Performance/Results

★ Performance

- ☞ System can disposition 150 defects in 6.5 minutes*
 - 5-6 times faster than what an operator can do
- ☞ Uptime of over 99.9%
- ☞ User level security and access

★ Results

- ☞ Currently over 80% of the IMO's production masks are simulated
- ☞ Over 50% of the defects do not need to be repaired!
- ☞ System has been running in production since Feb 2003

* Using 4x 2.5 GHz Xeon processors

- ★ Road to Total automation is unpaved
- ★ Lack of common minimum standards among various tool and building block supplier is a limiter in an environment where new tools are introduced at a rapid pace.
- ★ Intel spends resources in building single tool solutions. Standardization will reduce the cost and time to introduce new tools.
- ★ Several successful automation projects are in use today.
- ★ 45 nm node wish list (opportunity for Mask Shops to rally around)
 - ☞ Write/Inspection Design Data Standards –
 - Standard data format (OASIS) compact to transport and store
 - Common data & Jobdeck format to improve tools fungibility
 - ☞ Equipment Interface for automation
 - Standard data formats, Interfaces to support 100% automation of Recipe upload, Data collection & Parameters down load
 - Remote Diagnostics
 - Loading and Unloading standards
 - Fault Detection and classification/alarm
 - Automated process control enabling
- ★ Scheduling solution for mask shop differ from silicon and should be addressed