Guidelines for Reticle Data Management Ver.1.0 (English Version)

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Contents

1. Introduction

1.1Background

Through this semiconductor recession, the future situation of semiconductor industry has become apparent where various kinds of products vie in the limited demand. The trend to the limited production with a wide variety of SoC (system-on-chip) is remarkable. As a result, this trend increases severity of the following requirements: shorter life cycle of product, more difficult technique, lower cost, and shorter total TAT from design to shipping etc. Device venders, system venders, and material venders form a sector of semiconductor manufacturing technology. They are similarly forced to compete for the value to the business of device makers in the situation where capital investment and procurement cost continue to decrease.

Thus, in order to seek innovation of higher speed and efficiency, a major move has begun to utilize IT technology for manufacture of semiconductors. In the overall area of production technology, e-manufacturing has been introduced to every stage of production as utilization of IT technology, mainly Internet. Information is shared extensively through Internet. Not only that, powerful organization is intended to utilize more professional information such as devices. In this trend, production of a variety of products directly leads to thorough rationalization of many tasks involved for each reticle. This guideline has been planned against recognition of this background.

The trend of cost requirements

- A mask cost become more important in SoC business
- To shorten a manufacturing work flow (including a work flow of engineering)
- To reduce personnel (personnel required to compensate for loss generated by insufficient introduction of IT)

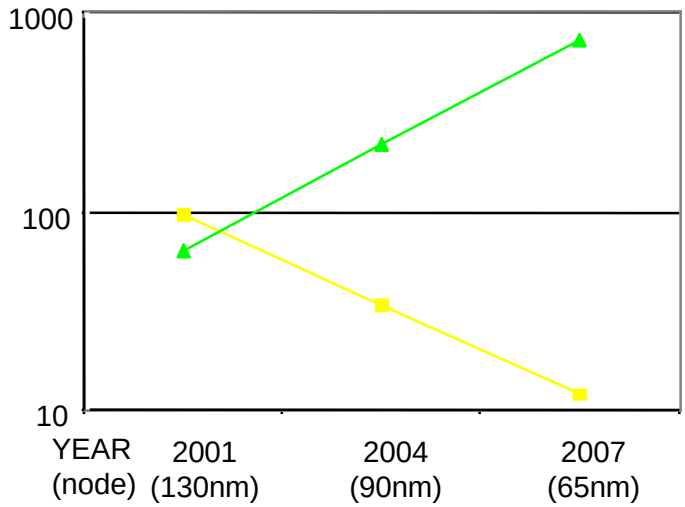
The trend of speed requirements

- The mask feed and preparation for production that correspond to completion of 20 sheets in 3 days including the previous process
- The mask feed preparation for production that corresponds to completion of 5 sheets in 1 day including the wiring process

Standardization of reticle data

Opportunity loss

- Inquiry through IT～scheduling～order-taking process becomes shorter--- Speedy action, information war
- Risk of losing an order due to plan confusion by rework



The unit price for each function must be reduced sharply. The data volume of a mask increases sharply. Therefore, epoch-making increase in efficiency is required for cost and date of delivery.

Figure 1. ITRS2001 roadmap

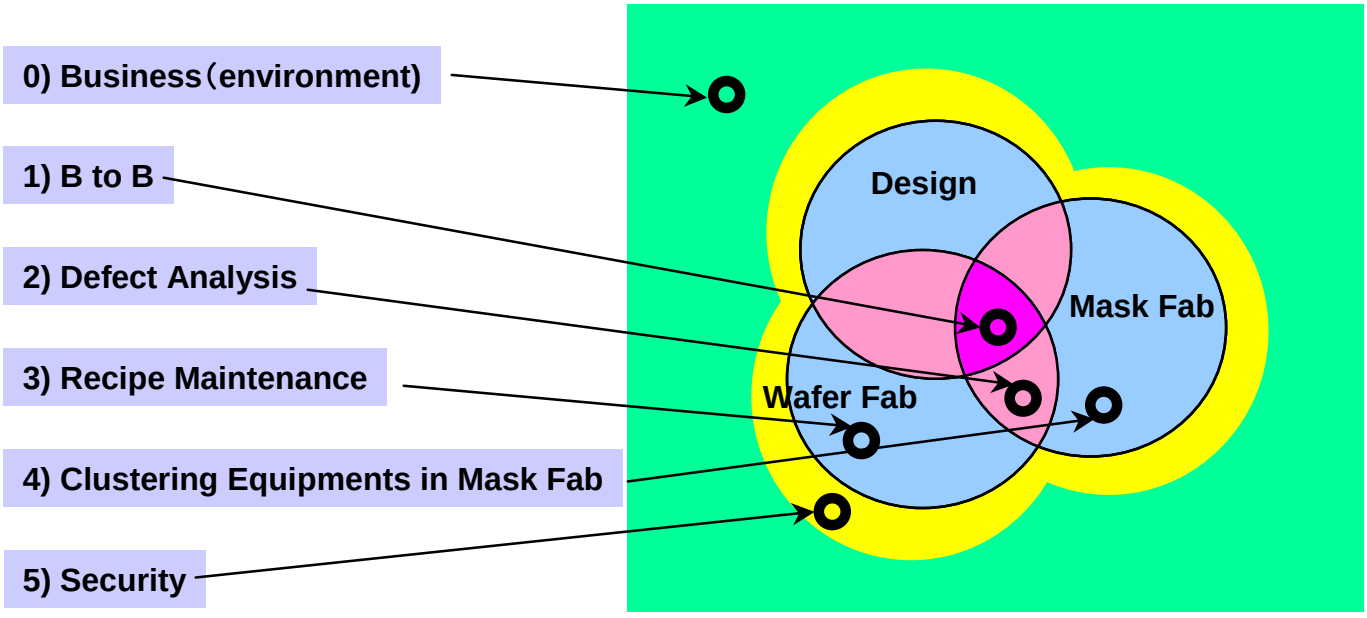
1.2 Purpose

As mentioned in 1.1 Background, the speed from design to merchandising is critical for digital electric household appliance and Internet-related devices. These devices are represented by SoC. Especially, in order to cope with the limited production with a wide variety of products, the speed for reticle tasks becomes critical. They include reticle feed, reticle-related preparation in manufacture, analysis of defect caused by reticle etc. The information related to reticle covers widely design, mask manufacture, and wafer manufacture. Despite a progress of partial automation, many exchanges of data rely on a conventional method such as telephone, resulting in loss of person-hours and time.

This guideline is primarily intended to address this issue by increasing efficiency consistently based on standardization that ranges from design, to mask manufacture, and to wafer manufacture.

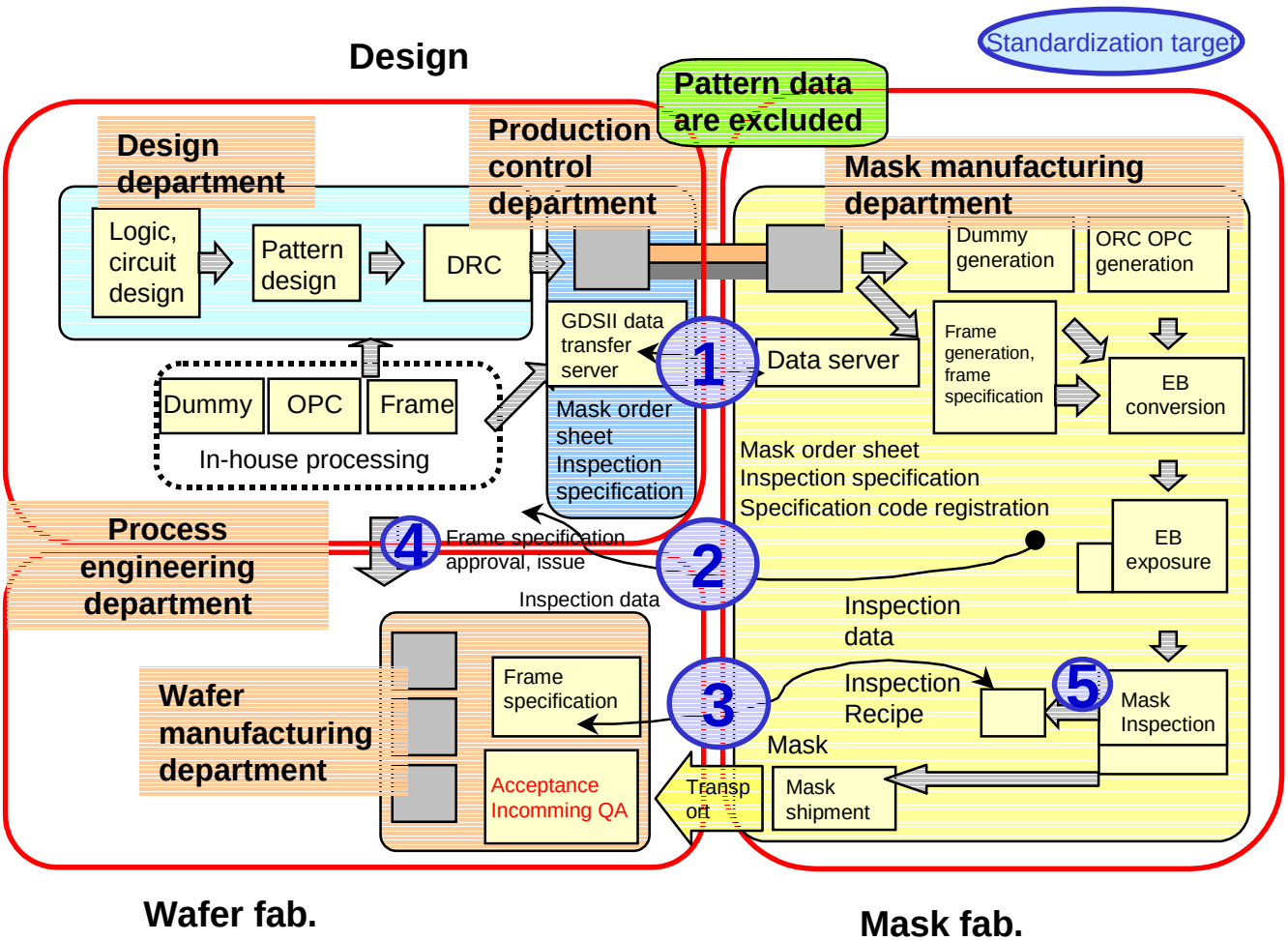
Secondly, this guideline is intended to support efficient deployment of new automation application business of device and production system venders, by enabling them to share information among the systems in the innovation where a variety of product are produced in a small quantity.

Items to be improved:



1.3 Scope

The following items, (1) through (5), are related to interfaces for information exchange (necessary minimum data structure for universal use of information) .
The scope proposes the guidelines for standardization of these interfaces.
(1)Production schedule, WIP tracking
(2) or (4)Quality Control in wafer fab.(recipe, device management, process monitor)
(3)Interchange and utilization of inspection, measurement data, and defect data
(5)Preparation of recipe of device in mask fab.
However, we exclude device H/W that is used for pattern data (graphic data required for CAD, OPC, PSM, TEG, and exposure/inspection), communication medium (network circuit, protocol), and device that is used for information interchange. In addition, the interfaces of above-mentioned (1) through (5) are so structured as to permit the mutual reuse of information.



1.4 Standardization objects and definition

To be excluded from these standardization objects

1) Circuit pattern data
A data part of a product (GDS data, plot data, comparison inspection data)

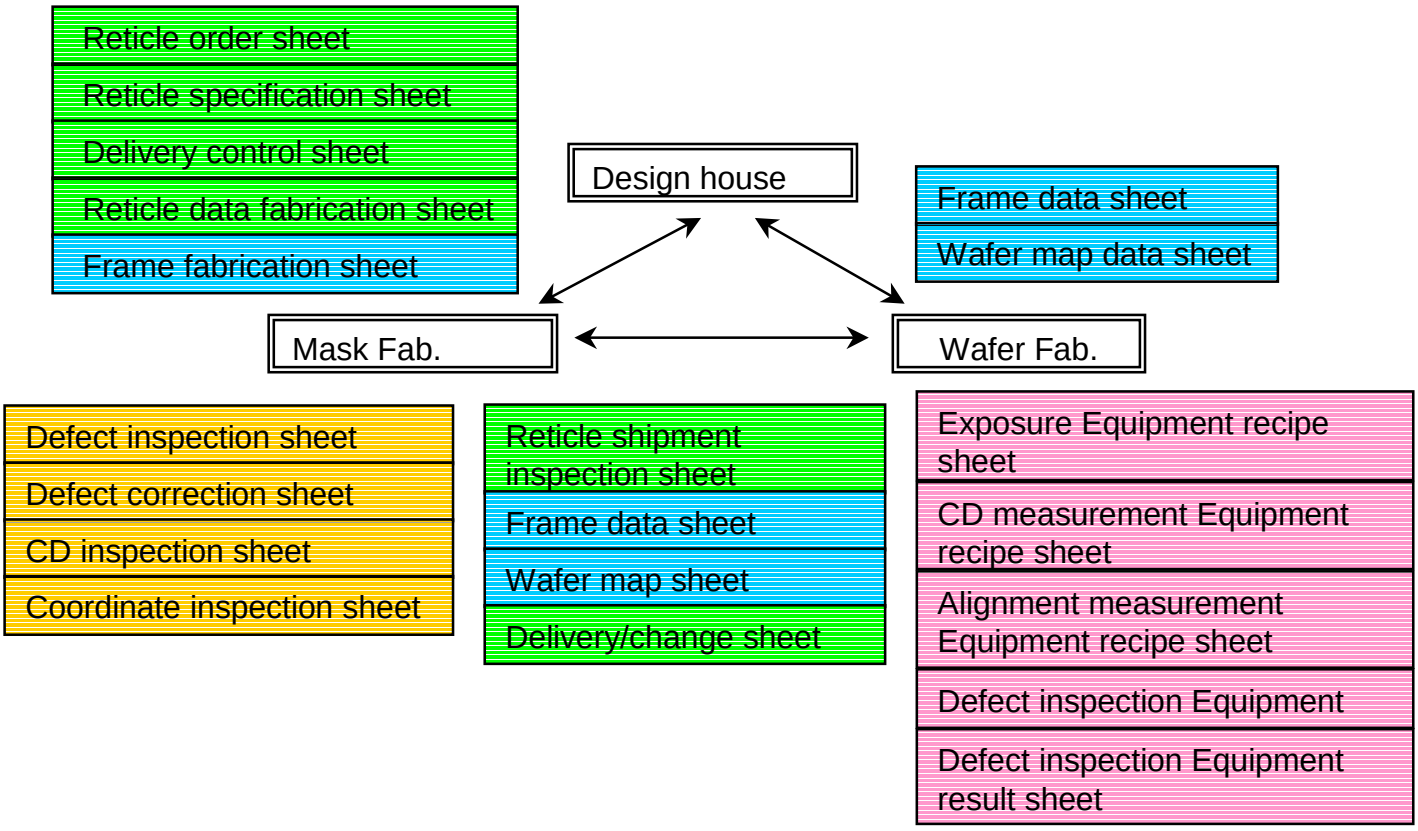
To be included in these standardization objects

2) Reticle data (calling the incidental data except circuit pattern data)
Reticle set specification sheet data (halftone, standard etc.)
Individual specification sheet
Pattern data (frame data and processing specification for CAD, plot, and inspection)
Inspection data (dimension, defect etc.)
Recipe data, correction parameter data

3) Reticle-related data
Management of plural reticle
Wafer inspection data (defect, dimension etc.)
History data
Tracking data
Order sheet data

Supplement

The above-mentioned standardization objects are controlled by the example sheets mentioned below.



Mask vender, mask device	Related to reticle data handling in mask house 1)Mask vender 2)Mask device vender 3)Selete
CAD, WP device, WP	Related to frame data (exposure device mark, inspection device mark, TEG, etc.) 1)WP device vender (exposure device, CD, alignment, defect inspection device) 2)CAD (frame CAD vender) 3)Wafer fab. user (JEITA)
CAD, WP device, WP	
Mask vender, WP	Related to order-taking and ordering, specification, delivery, change, inspection result 1)Mask vender 2)Wafer fab. user (JEITA)

1.5 Relationship with related standardization

This guideline deals with the interface of the data exchange of the information relevant to the reticle except pattern data. The activities of the overseas organizations that have complementary relationship are mentioned below..

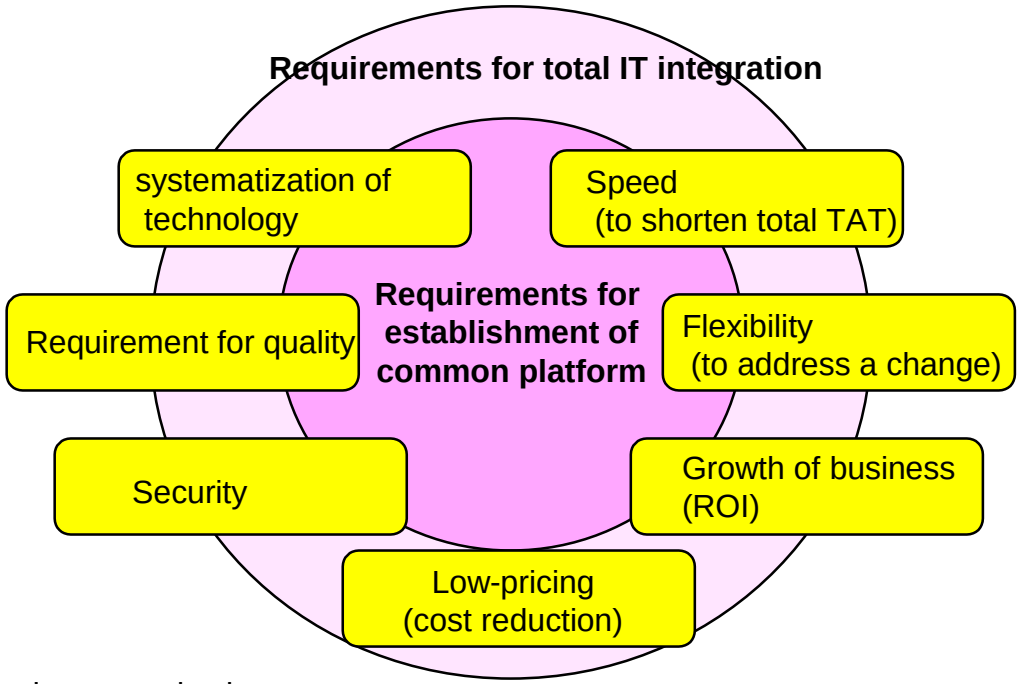
(1) SEMI-Japan Reticle Data Management Task Force
The standardization activities of micro patterning division
·It discusses the data-exchange method of the information relevant to a reticle.
·It intends to draft a guideline.
·It incorporates mask data into stepper recipe data preparation. It performs standardization of communication of reticle-related information among design～mask vender～ wafer fab.

(2) SEMI-NA Mask Data Path Task Force
Standardization activities of UDM(Universal Data Model) Working Group
·It discusses the data-exchange method of the information relevant to a reticle.
·It intends to draft a guideline.
·In this, Open Access Coalition of Silicon Integration Initiative (Si2) is introduced.
This consortium aims at offering the open standard to the IC design data access.

(3) MOPXE(Mask Order Processing In the eXtended Enterprise).
·This activity about the mask supply chain is proposed from IMS (Intelligent Manufacturing System). The activity is carried out mainly in Europe

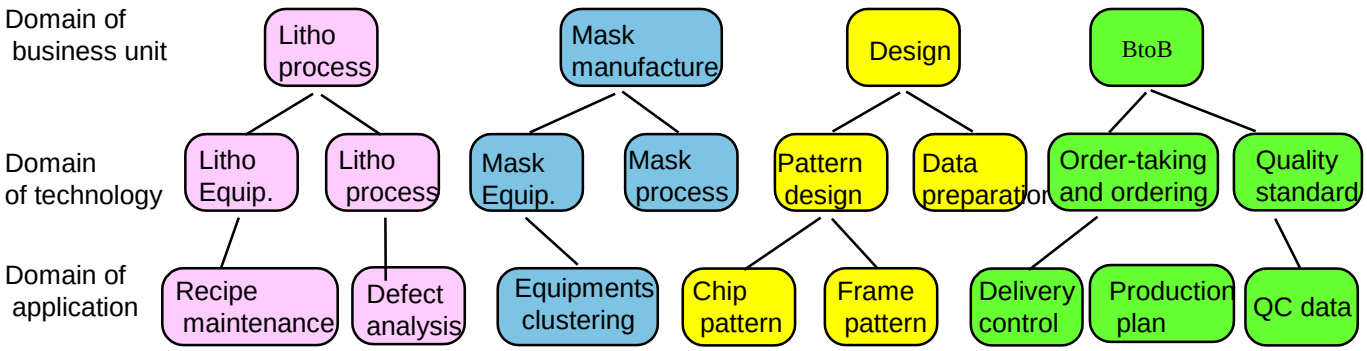
1.6 Requirement for establishment of common language for reticle-related information

The requirements for SoC business of small production of many kinds of products lead to requirement for establishment of common language through requirement for total IT utilization. Utilization of many techniques that is based on XML in IT area must be so developed as to support the requirements for SoC business.



1) Technical systematization

The speed of technical accumulation is accelerated by IT technology. For that purpose, technical systematization that aims at high availability is required. The reticle-related information must be formulized in terminology/definition/methodology about several aspects of utilization, accumulation, and exchange in a wide area.



Necessity of interoperability among various domains

Reticle-related information is used by the entire area of domains through partial relationship.

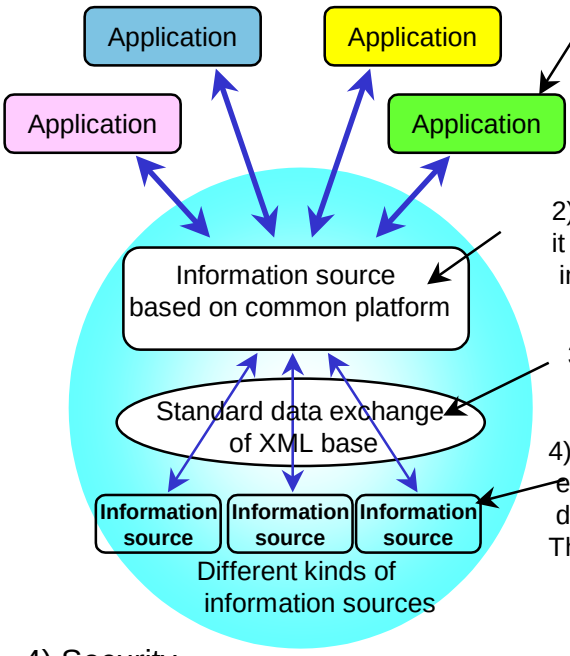
Necessity of semantic interoperability is large.

2) Flexibility

Production technology must continue to innovate obsolete technology to cope with an ever-changing market, and IT technology must be easily updated. In addition, the reticle-related information is generated and use in various aspects, and a data model with high flexibility is required.

3) Return of investment in business

Activation of information service based on standardization is required to reduce the introduction cost. Owners and users should be clarified according to information classification. Collaboration should be realized among device makers, mask makers, equipment makers, and system makers. For that purpose, various business model should be built where security is precisely set up and license and fees are established.



1) Application eliminates the connection cost, and emphasizes functions that create values. It is possible to obtain the development flexibility that overcomes the speed of obsolescence. Both distribution and IP of application are attempted.

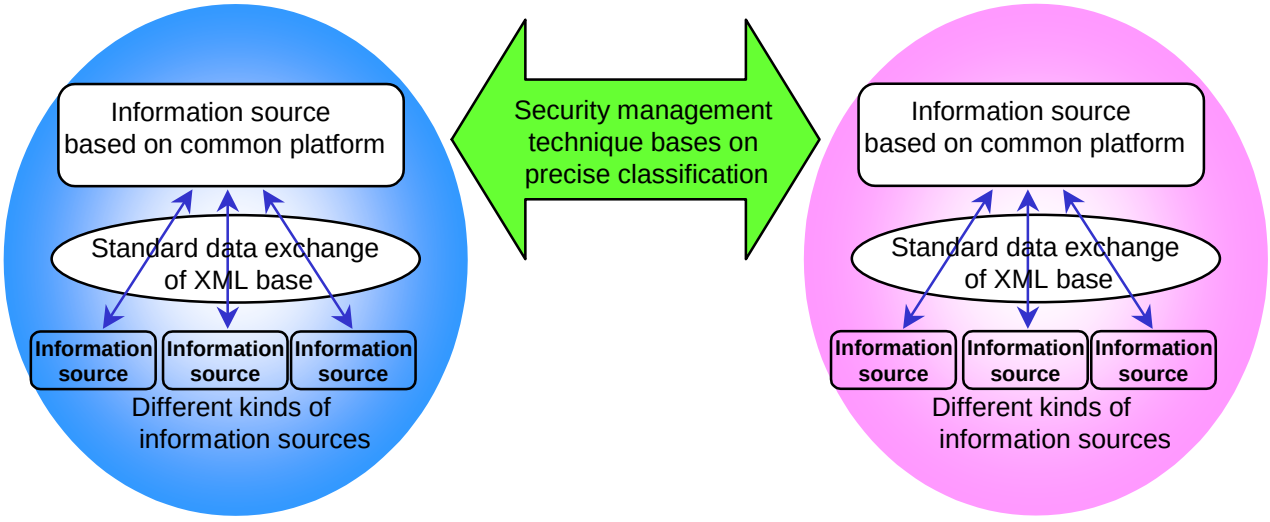
2) By controlling the meaning and source of information, it is possible to measure the value of information supplied and to activate business.

3) It is possible to instantly monitor various information that is generated widely and asynchronously in Internet.

4) Data are standardized by XML and wrapped for data exchange. It is possible to permit Inconsistence of various data between different kinds of information sources. Thus, it promotes development of individual information sources.

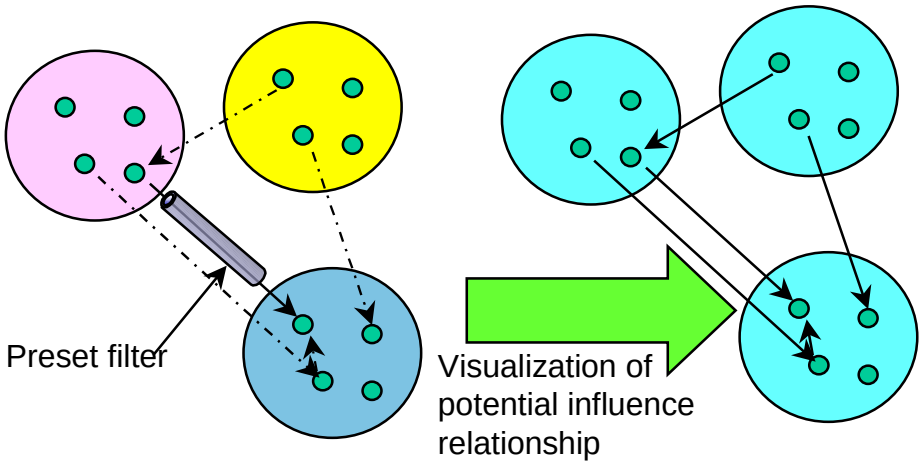
4) Security

The information about a reticle must be maintained at high security for a customer. Share information must be systematized to set up security management that is partitioned appropriately and efficiently for various security requirements and usability requirements.



5) Quality

As the technology becomes more difficult, lack of consideration about quality generates the maximum loss. Application of IT technology to semiconductor production technology is not limited to a superficial support for quality control . It needs to support by incorporating analysis, which was difficult because of shortage of labor in the past. The requirements for quality of a reticle are also increased. Therefore, efficient development should be supported.

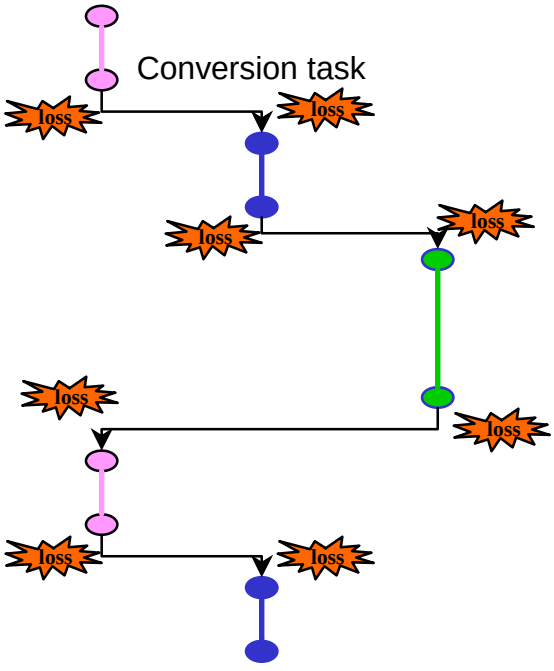


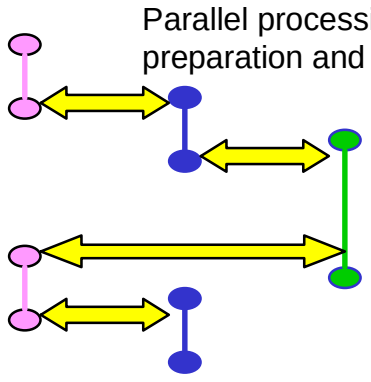
6) Cost

In order to reduce the cost for every reticle under small production of various products, it is necessary to eliminate every loss that is dispersed and generated in an extensive area and to obtain an integral effect. Not only that, it is necessary to establish standardization that is suitable for Internet technology in order to realize a wide information exchange inexpensively.

7) TAT

In order to make it contribute to ultimate product TAT realization, you should eliminate break and leakage in a total work flow. For that purpose, you should consider main stream design data that range from design to mask manufacture and to wafer manufacture. Not only that, you should include information that is information generated derivatively and consider possibility of wide reuse.



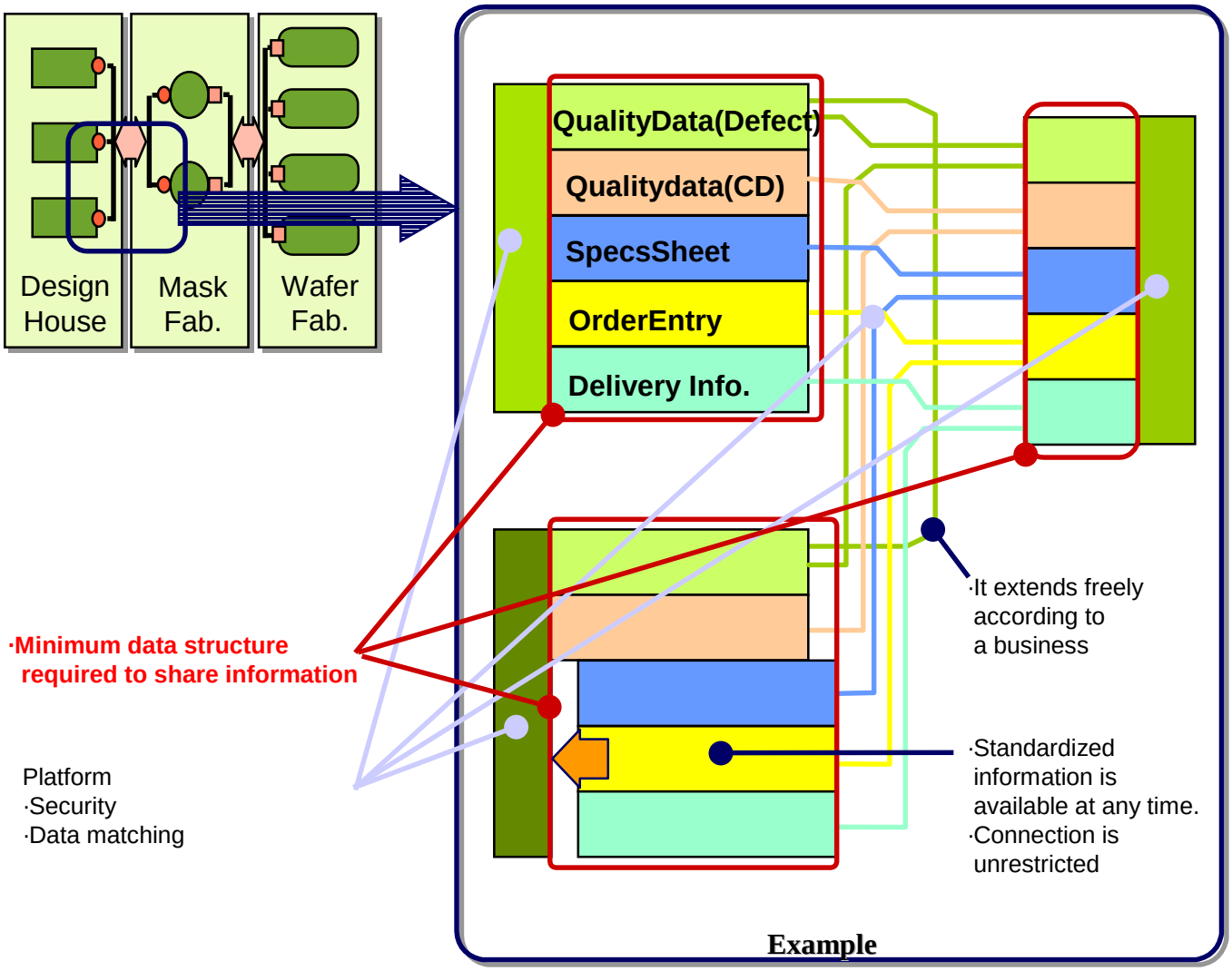


2. General guideline

2.1 Sharing of reticle data

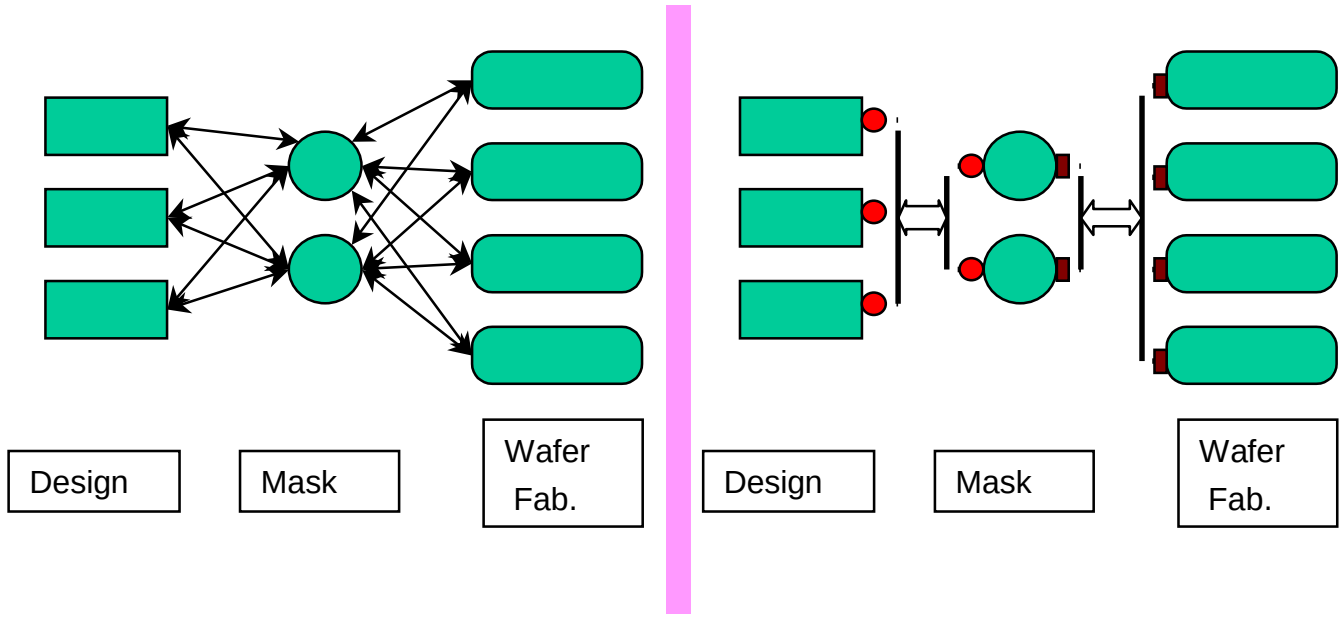
The environment that can be utilized in common from design to wafer fab. must be established being fulfilled the following conditions.

Conditions :
1. Reticle data and reticle-related data must be correlated with a hierarchic configuration.
2. Reticle data and reticle-related data must be delivered in a standardized method at each interface.
3. Reticle data and reticle-related data must be defined clearly in their contents.
4. Reticle data and reticle-related data must be stored for each fab. so that the required data can be taken out whenever necessary.
5. Reticle data and reticle-related data must be protected by the reasonable security system.



2.2 Outline of shared guideline covering design, mask manufacture and wafer manufacture

Interchange of various data that were explained above has been built by individual association at B to B until now. The left-hand figure shows continuing building of individual
association, while the right-hand figure is based on standardization of processes that ranges from design of reticle data and reticle-related data to mask manufacture and
to wafer manufacture. The individual know-how and the common data exchange are associated and controlled respectively, and overall complex processes can be simplified.



B to B	Shared data	Items for standardization	
		QC flow	Data handling
Design house ↔ Mask fab	Chip size Block configuration Reticle set mark CD (On wafer/reticle) Defect Orthogonality Shrink Alignment mark	Guideline for mask order-taking and ordering system and data handling (toward creation of standardization format) (ref: P10)	
Mask fab. ↔ Wafer fab.		Guideline related to frame data (exposure device mark, inspection device mark etc.) (toward creation of standardization format)	
Wafer fab. ↔ Design house.		Guideline for design (technology unit) and photolitho manufacture standard (wafer, reticle accuracy) (toward creation of standardization format)	

3. Guidlines for Applications

3.1 Order-taking and Ordering of Mask

(1)Guideline for Order-taking and Ordering of Mask

Mask order-taking abd ordering information must be shared from design to mask fab. and to wafer fab

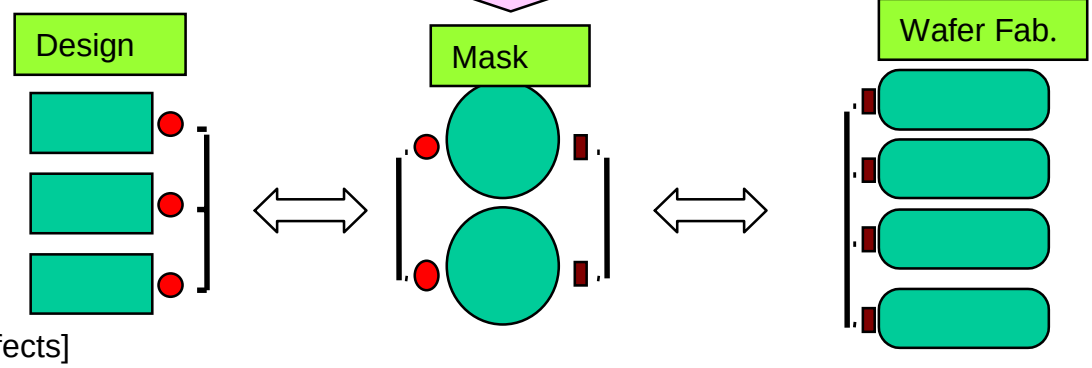
For data handling, a business model must be flexible enough to meet the requirements of both parties concerning various formats for drawing, text, GDS, Mebes etc.

The status report of each mask must be shared among order-taking, ordering, and production control of reticle database in order to report mask making progress report and forecast deliverly it for customer. This mask supply is and will be a key for a fine patterned device. This will be an issue whether you produce a mask in-house or not.

[Common items for order-taking and ordering of mask]

1) Design data (drawing, GDS II, Mebes etc) (including frame data)
2) Manufacture request sheet (a masking name, new edition, revision, reprint, size, pellicle class, specified date of delivery, destination)
3) Manufacture conditions (manufacture data specification, exposure data arrangement
specification, manufacture specification, and inspection specification)
4) Progress
5) Specification (grade)
6) Quality (dimension, arrangement, defect, phase difference, transmittance)
7) Inquiry

Shared environment of order-taking and ordering



[Effects]

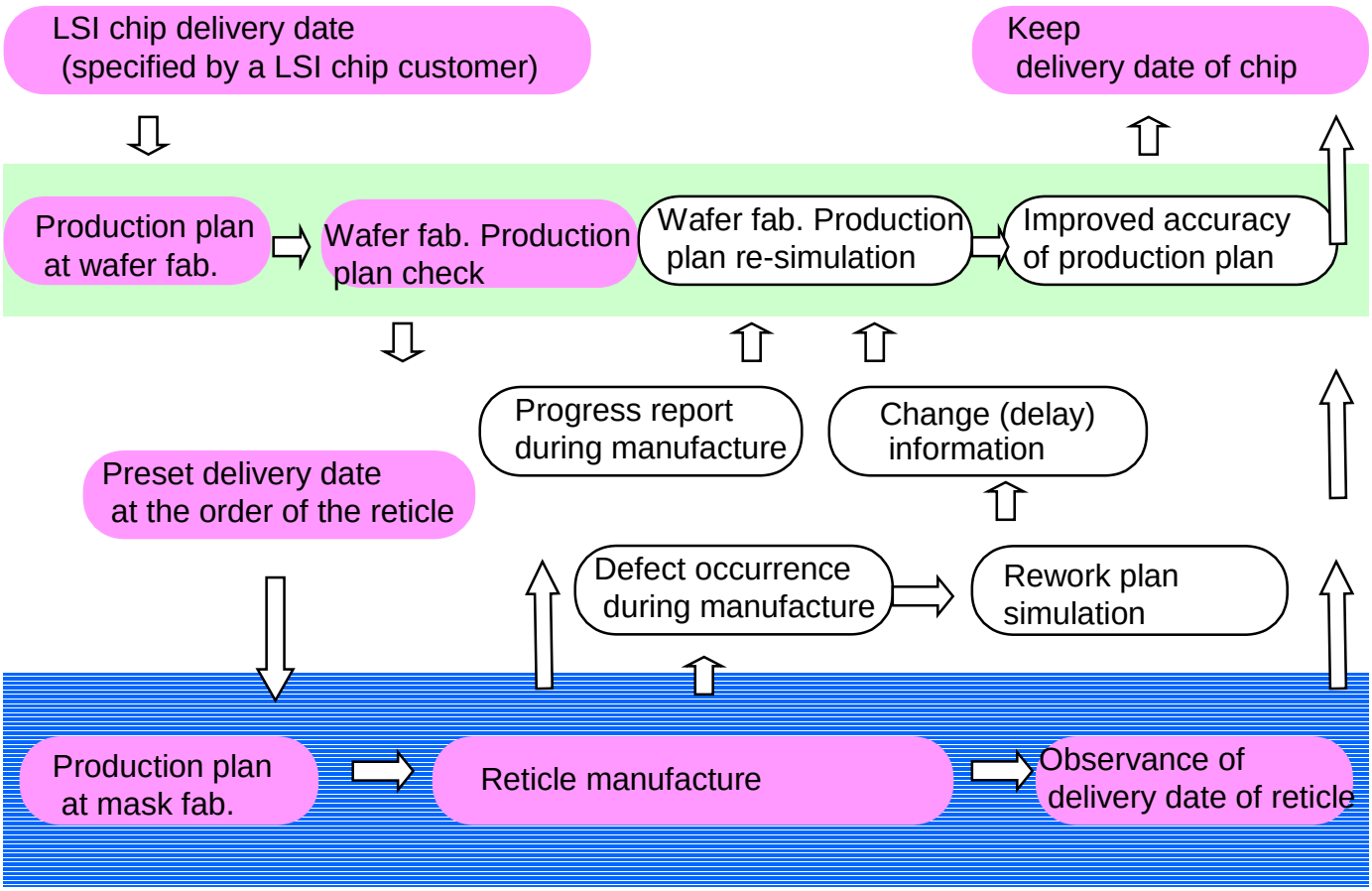
- You can service all customers more quickly than now
- You can reduce system development cost

(2) Mask Progress report and Deliverly forecast program

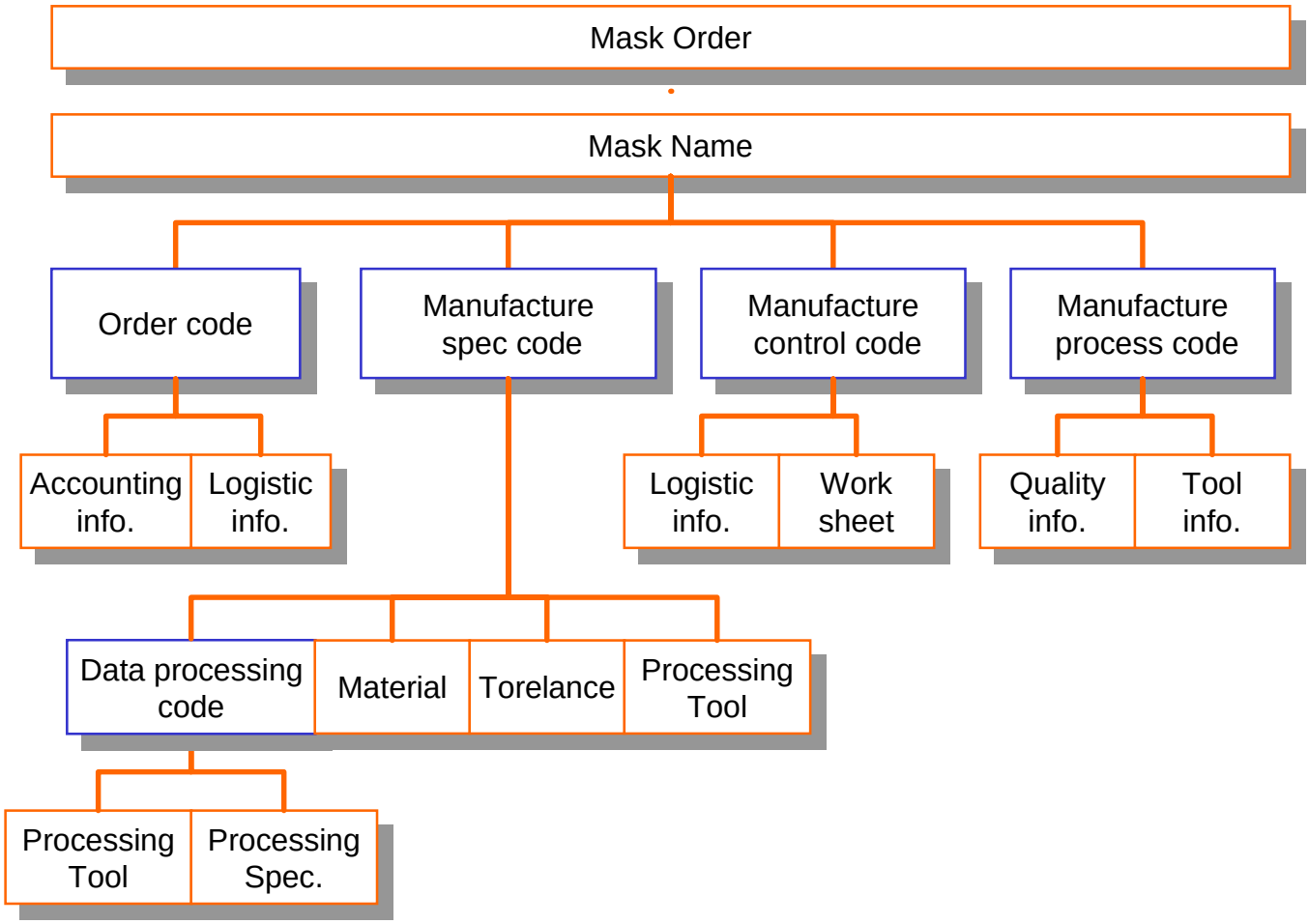
Mask fab. should offer wafer fab. the updated information including delivery schedule of rework of reticle manufacture. Both should offer the standardized interface.

Reticle data management —Just-in-time program

Timely prediction of delivery(● part) is added to the conventional B to B (○ part) in the standardization. Thus, B to B cooperation can eliminate waste that is observed by a customer.



(3) Mask Ordering Data forXML (Structured Reticle Data for Order)



3.2 Increase in efficiency of analysis of reticle defect

The reticle data and reticle-related data must be ready for wafer fab. to refer those for analysis of quality in wafer fab. (defect, dimension etc.) whenever necessary.

Example 1) You use the reticle data and reticle-related data so that you can judge whether the quality in wafer fab. originates in a reticle or not.

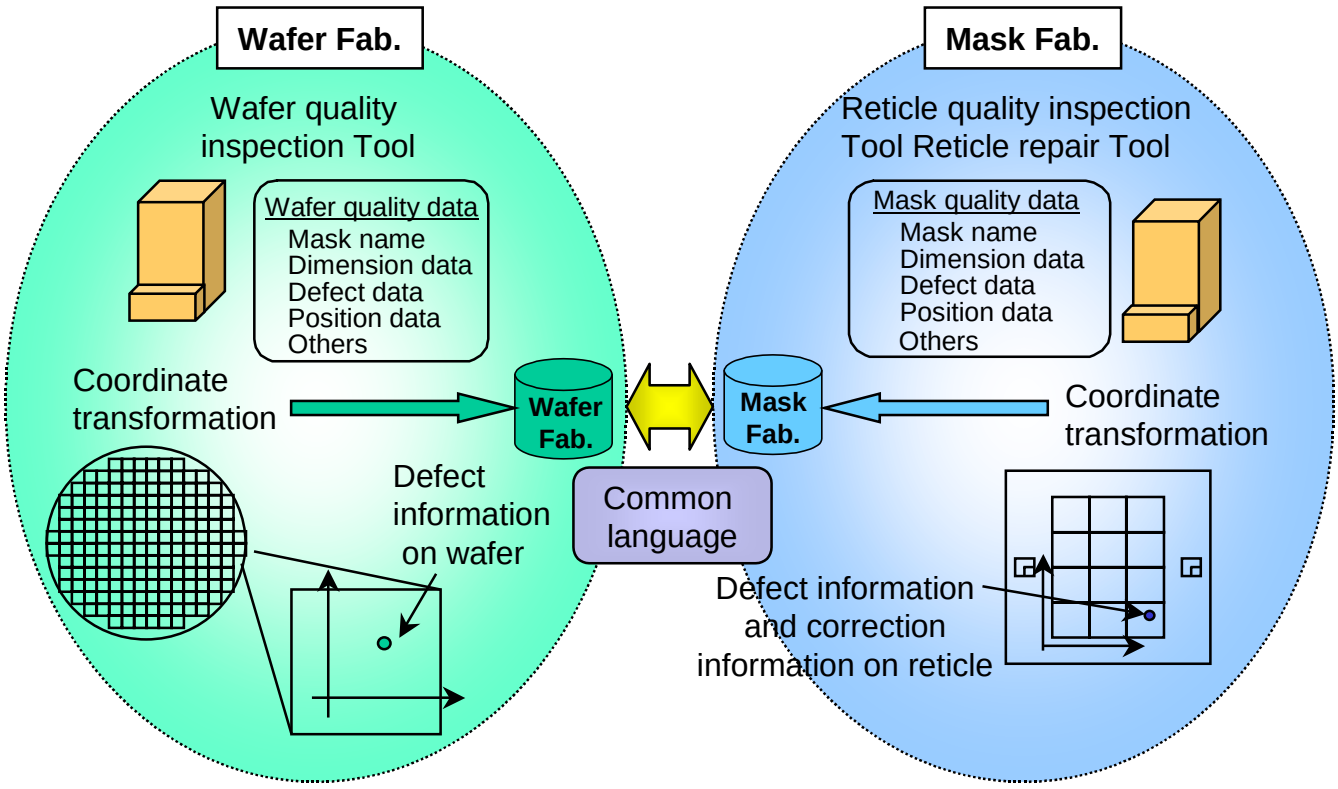
Example 2) You correlate quality information of a reticle with that of wafer so that you can increase efficiency of the process improvement of reticle manufacture.

[Examples of effects]

- You can improve the quality of mask
- You can increase efficiency of the quality analysis in wafer fab.
- You can clarify the criteria of quality, optimize mask production process, and reduce a manufacturing cost
- You can reduce the cost to develop a tool to analyze correlation between mask quality and wafer printing characteristics.

[Example of methods]

- You feed back the wafer printing result to the mask fab. and accumulate the data about correlation between mask quality and wafer printing characteristics
- You feed forward the quality information of mask manufacture process to the wafer fab. and utilize it for the quality analysis at wafer fab.



3.3 Increase in efficiency of recipe build in wafer fab

Guideline of Standardized Reticle design information and QC data to make reusable it for recipe build in Wafer Fab.

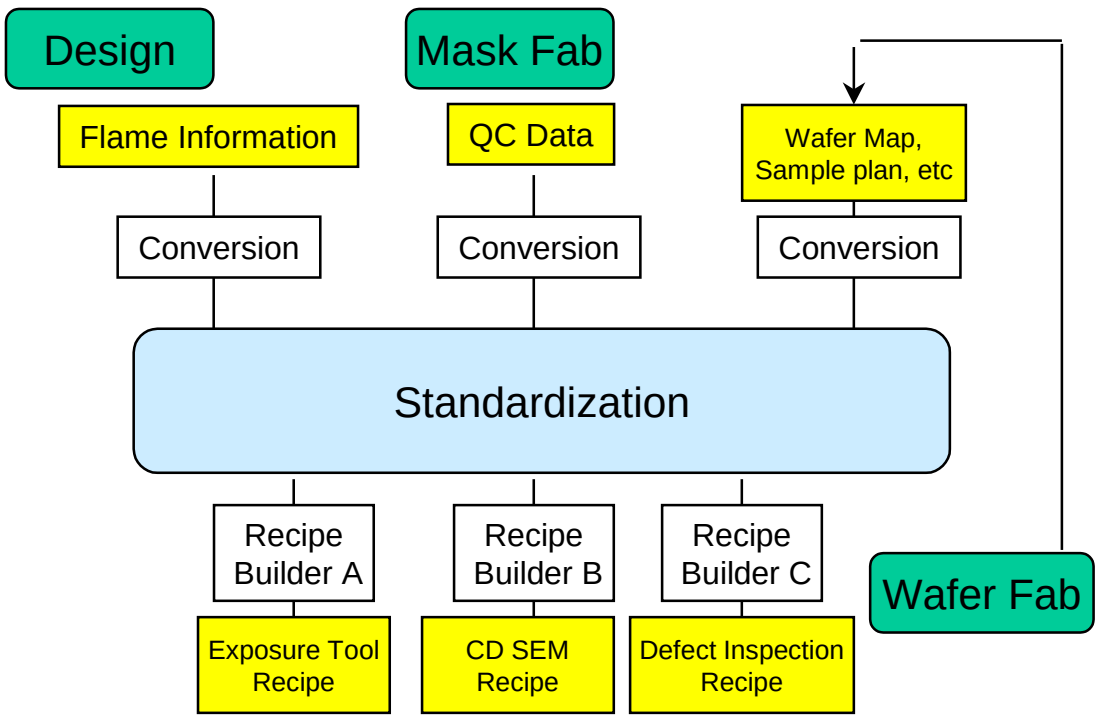
1) The data that are related to recipe build of systems, such as exposure tools, inspection tools, APC, MES, etc. are generated in various data sources throughout the design shop, mask fab. and wafer fab. In order to address various quality requirements in the future, you need a flexible method based on the common formats of data.

[Effects]

- The time of recipe building at wafer fab. will become quick.
- The cost for developing recipe build system will be minimized.

[Methods]

- Mask flame information, mask quality information, wafer map and sample plans are provided as standardized format data from each site. Recipe builders import these data and make recipe.



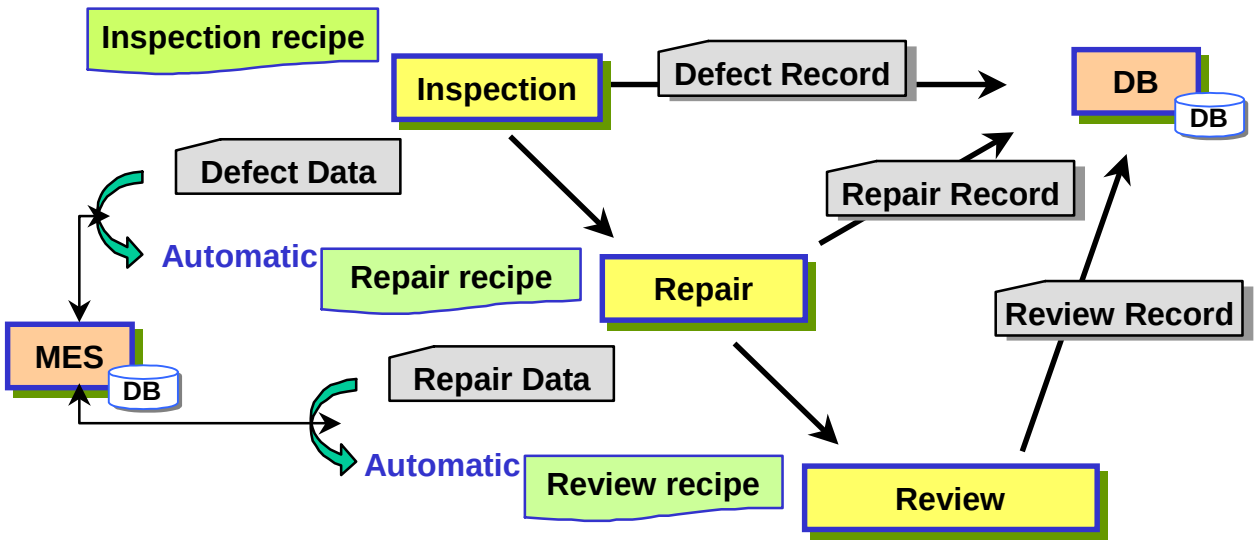
3.4 Data sharing within mask fab.

The data and information within Mask Fab.; inspection, defect correct and review tool, should be able to be shared for mutual reference of data as necessary.

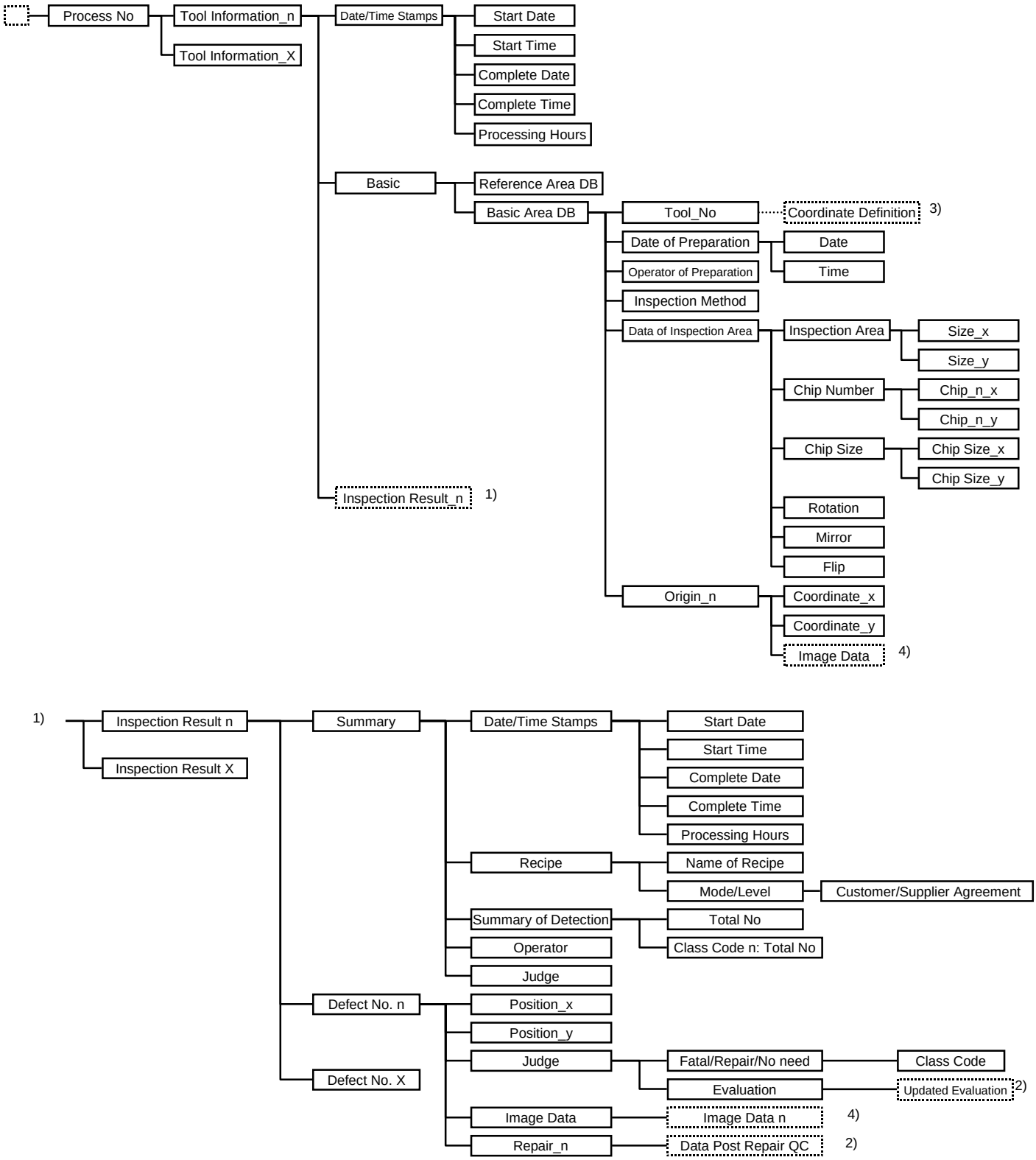
1) Reticle defect correction process use many tools;inspection, defect correction and review. This correction will be efficient, if tools can share there results and recipe.

[Effects]
- Can shorten the time to create a recipe at the process of mask defect inspection, defect correction and review by reuse of information i.e. coordinates information etc.
- Can reduce the development cost of a recipe by preparing standard or flexible data format
- Can improve mask quality by integrate information related to mask defect.

[Methods]
- Collect, store, report and analyze the information about mask defect and processing information.
- Associate and integrate the information about mask defect at wafer manufacture process and the information at mask manufacture process.



Example) XML Data Tree of Inspection Tool



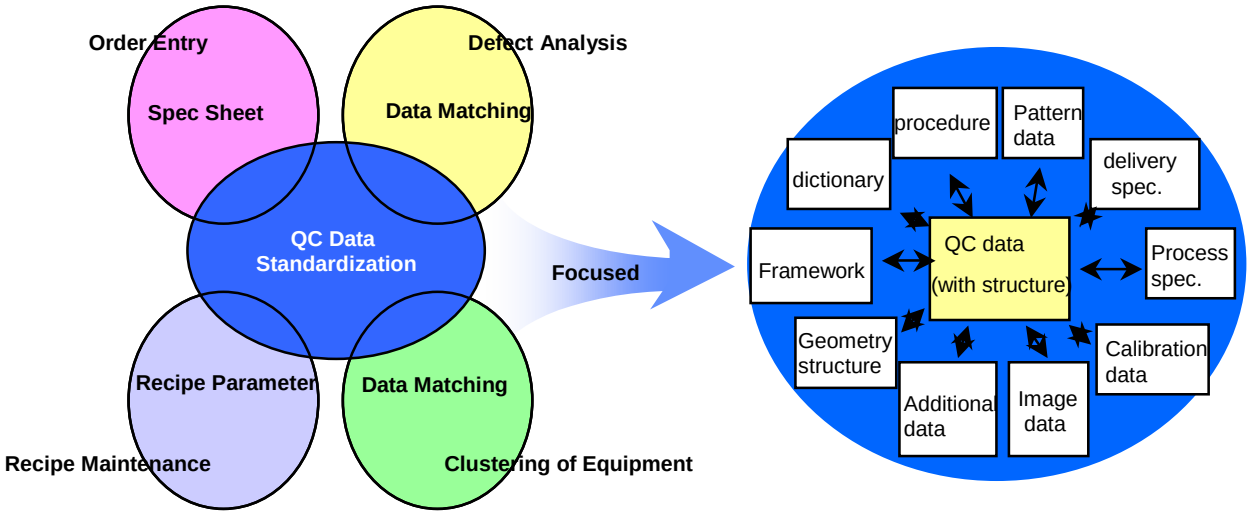
3.5 Reusable QC Data

At B to B, standards information should be exchanged in the standardized items.

1. Classification of information
   1) Wafer Fab. standards information
      - Order sheet - Spec sheet
   2) Mask Fab. standards information
      - QC sheet
2. Merit: Improvement of productivity and reduction of cost

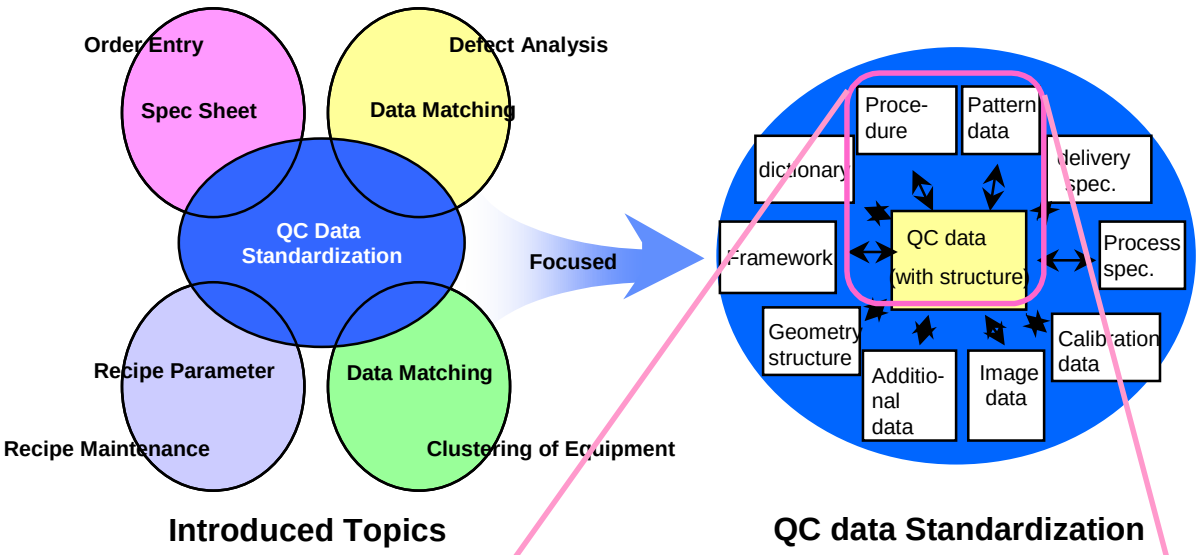
Methods :
Expansion of reusability of QC information by standardization of different section (definition and usage of QC data at Wafer, Mask and Design)

1) As to QC data, you standardize such components that can be stratified and shared. You should deal with data handling in a standardized method.
2) You should use classification and stratification for communalization. You should promote first the area that is easy to communalize, namely that is highly common or highly abstract.



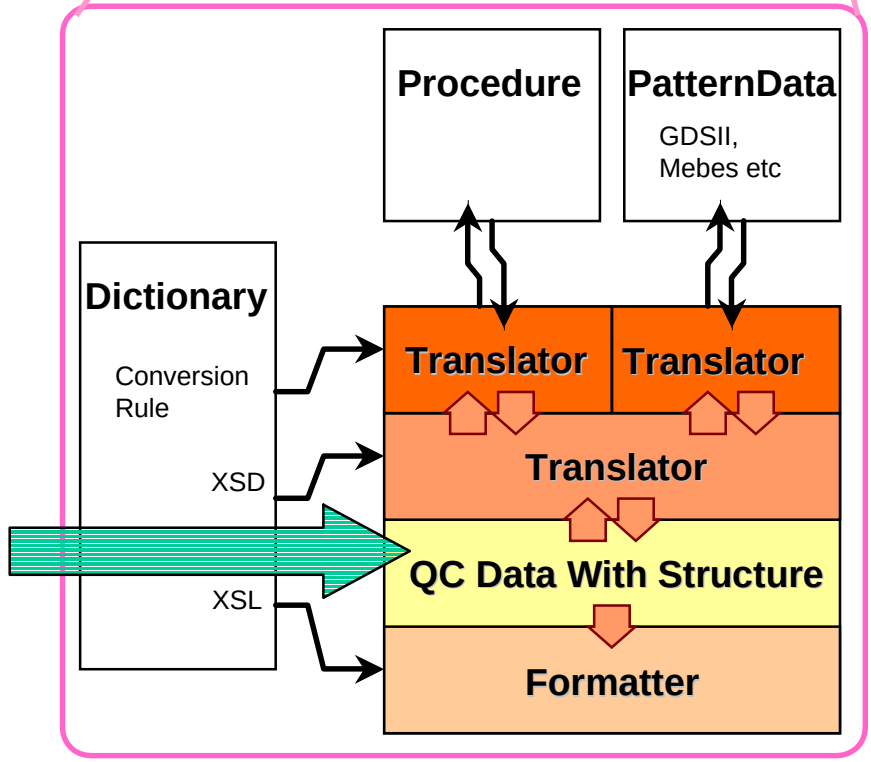
Introduced Topics **QC data Standardization**

Examples of sharing of procedure and pattern data



Introduced Topics

QC data Standardization



Reticle Data Management Target

Example

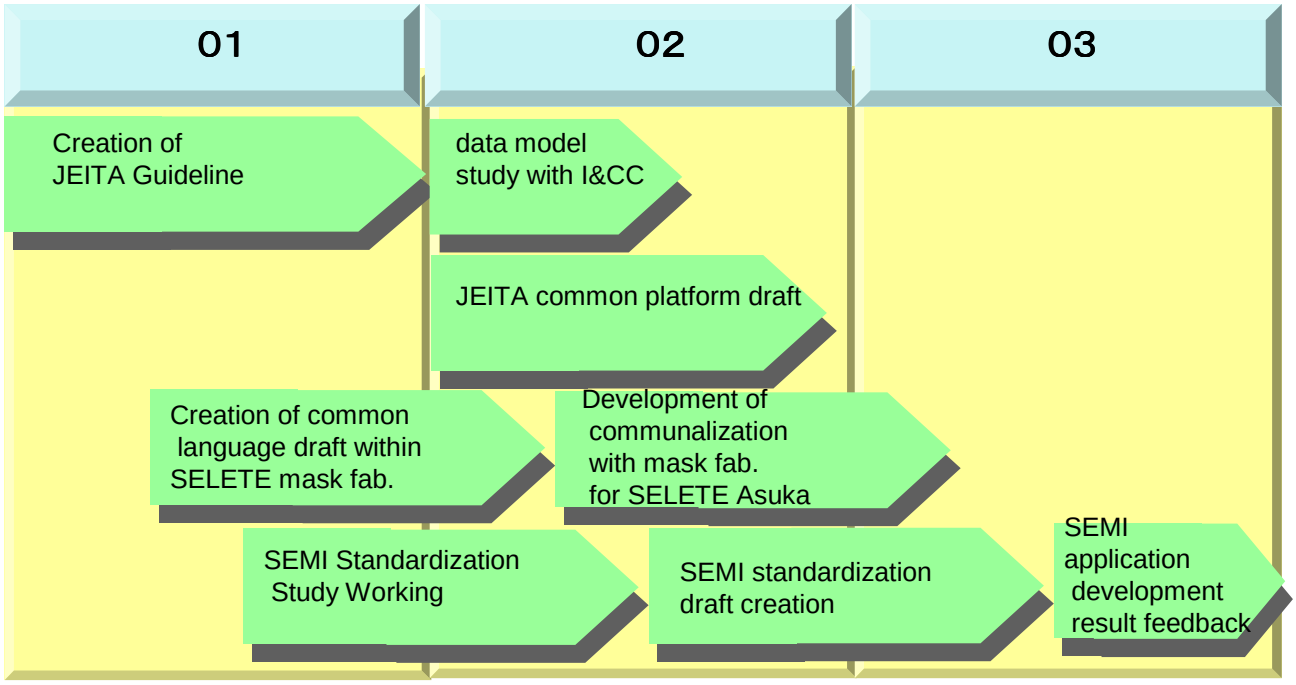
Example)
QC data of order-taking and ordering of mask

1) Shipped Mask Number
(for each type of product, each grade, each technology, each size,
new edition, revision, reprint)
2) Just-in-time Delivery Deticle Ratio
3)TAT
4)Quality (CD:uniformity/mean to target, Distortion, Defect)
5)Tool (Tool Up Ratio, QC/Pre Maintenance result)
6)Failure data

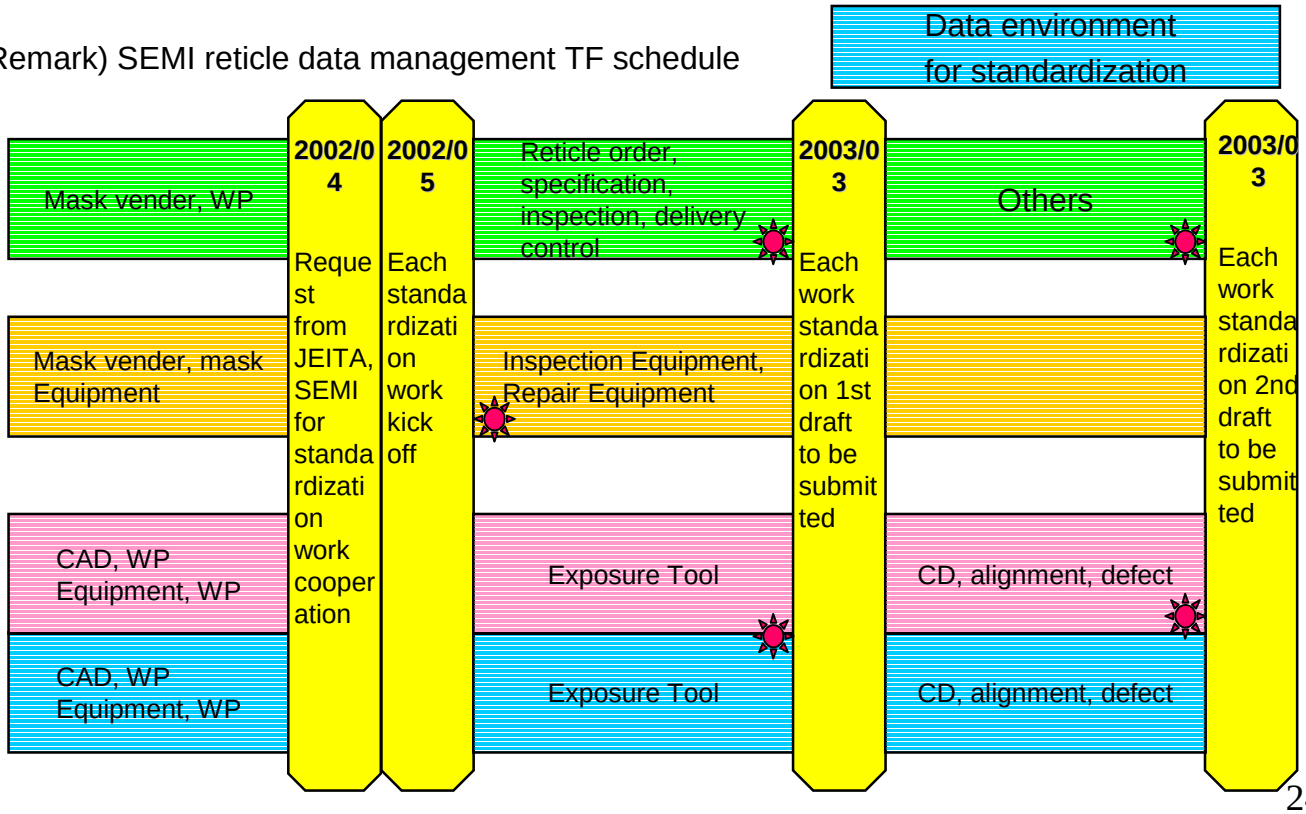
* : Data must be read on a platform. Production control and quality contro
l should be shown daily, weekly, and monthly.
Those data must be updated to reticle production plan
and development plan.

4. Standardization and implementation procedure
4.1 Activity organization and schedule

Reticle data management—Future schedule



Remark) SEMI reticle data management TF schedule



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