

Jeita300PrimeGuideLine

<http://www.jeita-smtj.com/>

Toshihiko Osada

Technology Development Division

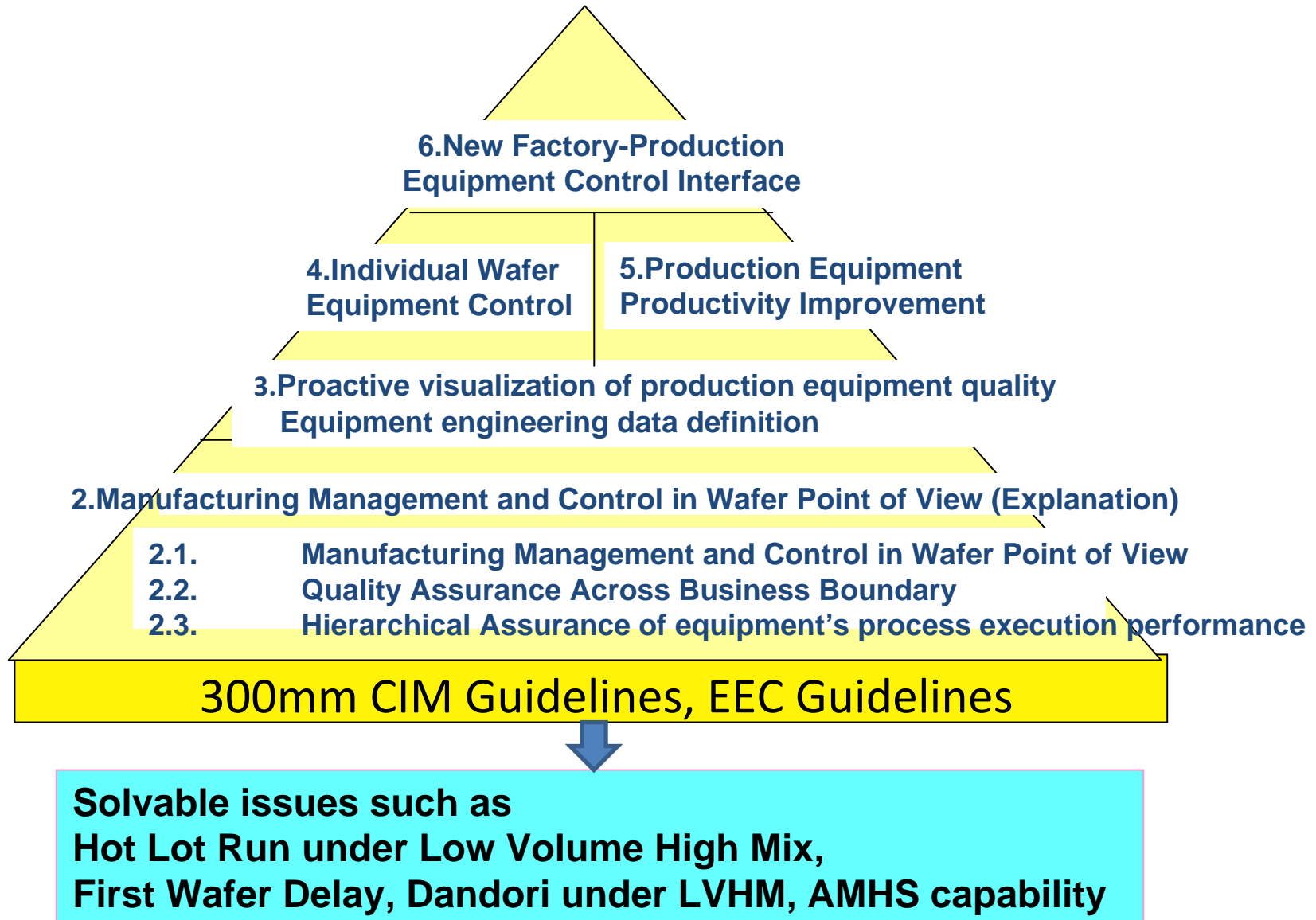
Fujitsu Ltd.

Jeita 300 prime Guidelines

simultaneously aims at,

- coping with pattern size reduction
 - by reducing variation
- improving OEE (30%up)
 - by reducing machine loss and improving efficiency
- reducing Cycle Time (50%down)
 - by prioritizing Wafer process order

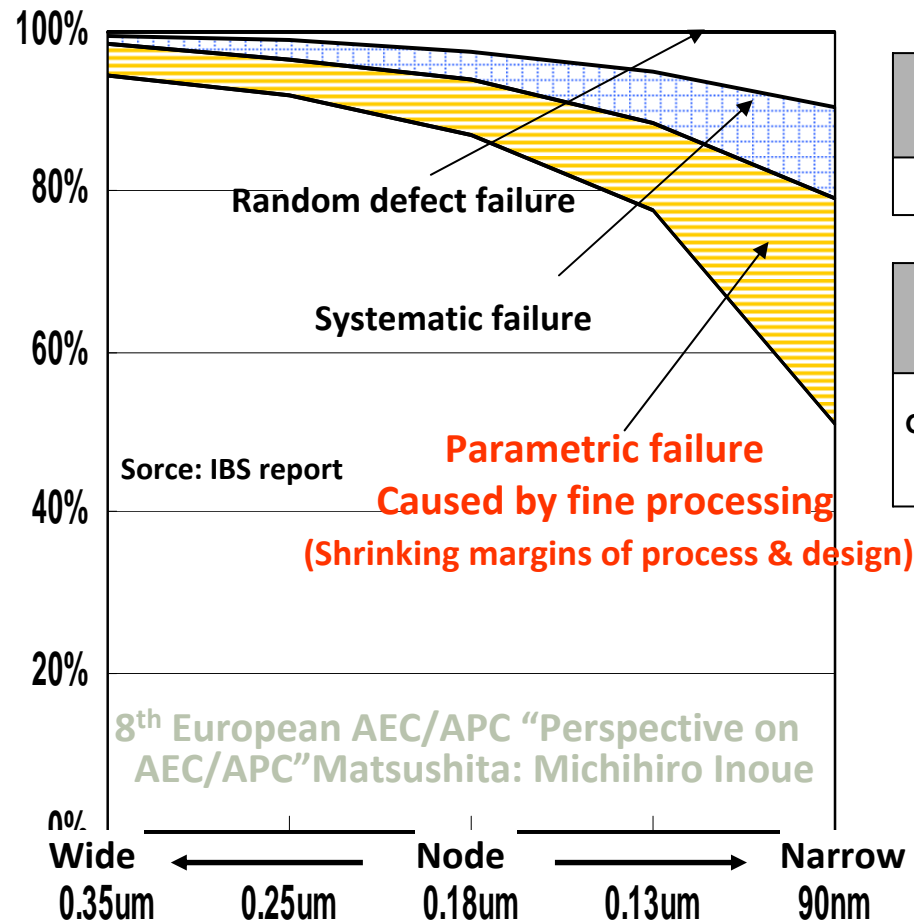
JEITA Guideline framework



Pattern Size Reduction

Issues of Mass Production for beyond 45nm Process

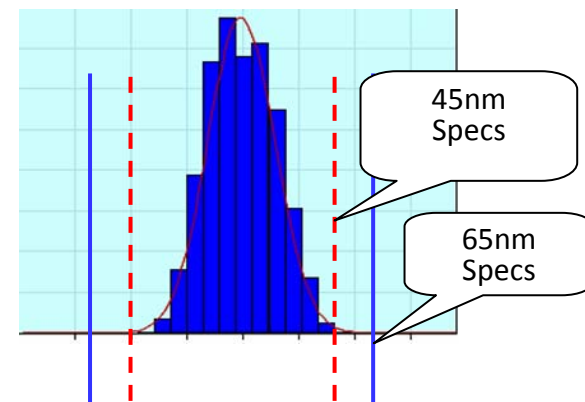
- ◆ The dominant cause for yield loss is parametric failure led by fine processing.
- ◆ The issue of variances in equipment performance becomes fatal due to shrinking margins of process and design



Cause of yield loss by fine processing

	ITRS specs		
	65nm	45nm	32nm
L (nm)	45	28	20

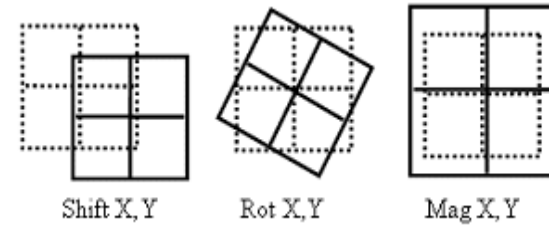
	Relating process	ITRS allowable margin		Margin shrinkage 45nm/65nm
		65nm	45nm	
Gate length (L)	Lithography	3SIGMA <3.00	3SIGMA, 2.16	0.72 times
	Etching			
	Cleaning			



<Gate length (Post-dry etching)>

Causes of Variation

- Equipment Drift
- Chamber Difference
- Maintenance
- Durable



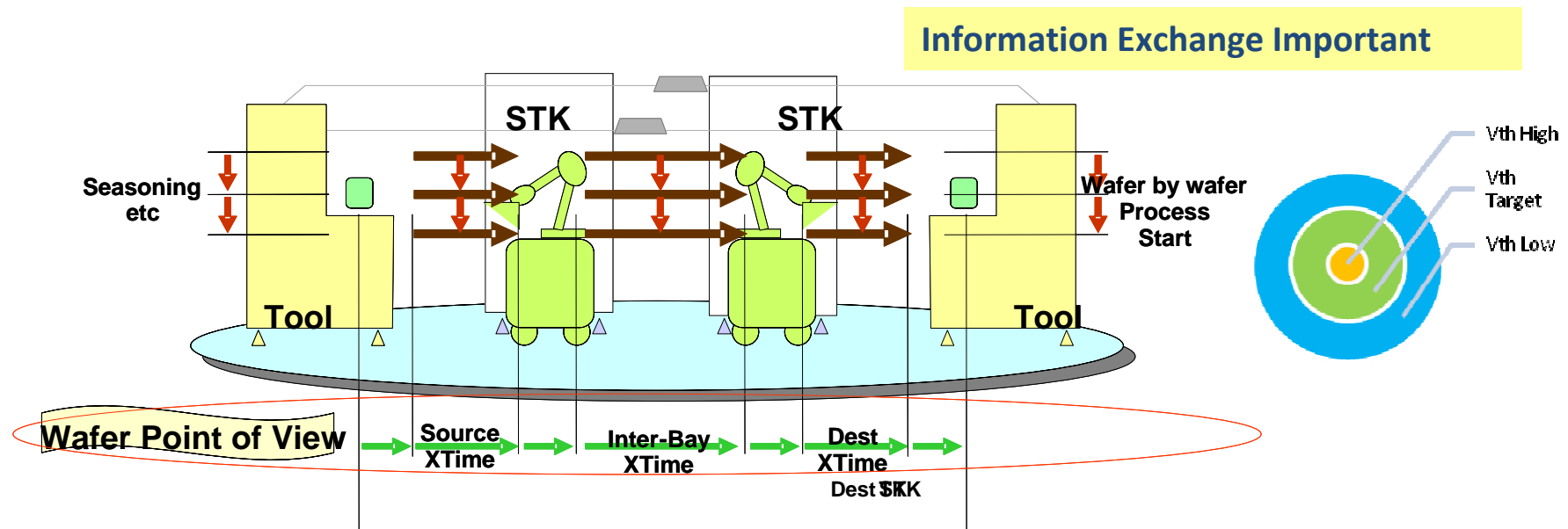
Model of overlay errors

	Photo Cell	Etch	CMP
Lot to lot	Drift	Drift	Platen Cond.
Wafer to wafer	Drift	Chamber Cond.	Platen Cond.
Across Wafer	PEB plate	Chamber Cond.	Material
Across Chip	Reticle	Non	Non

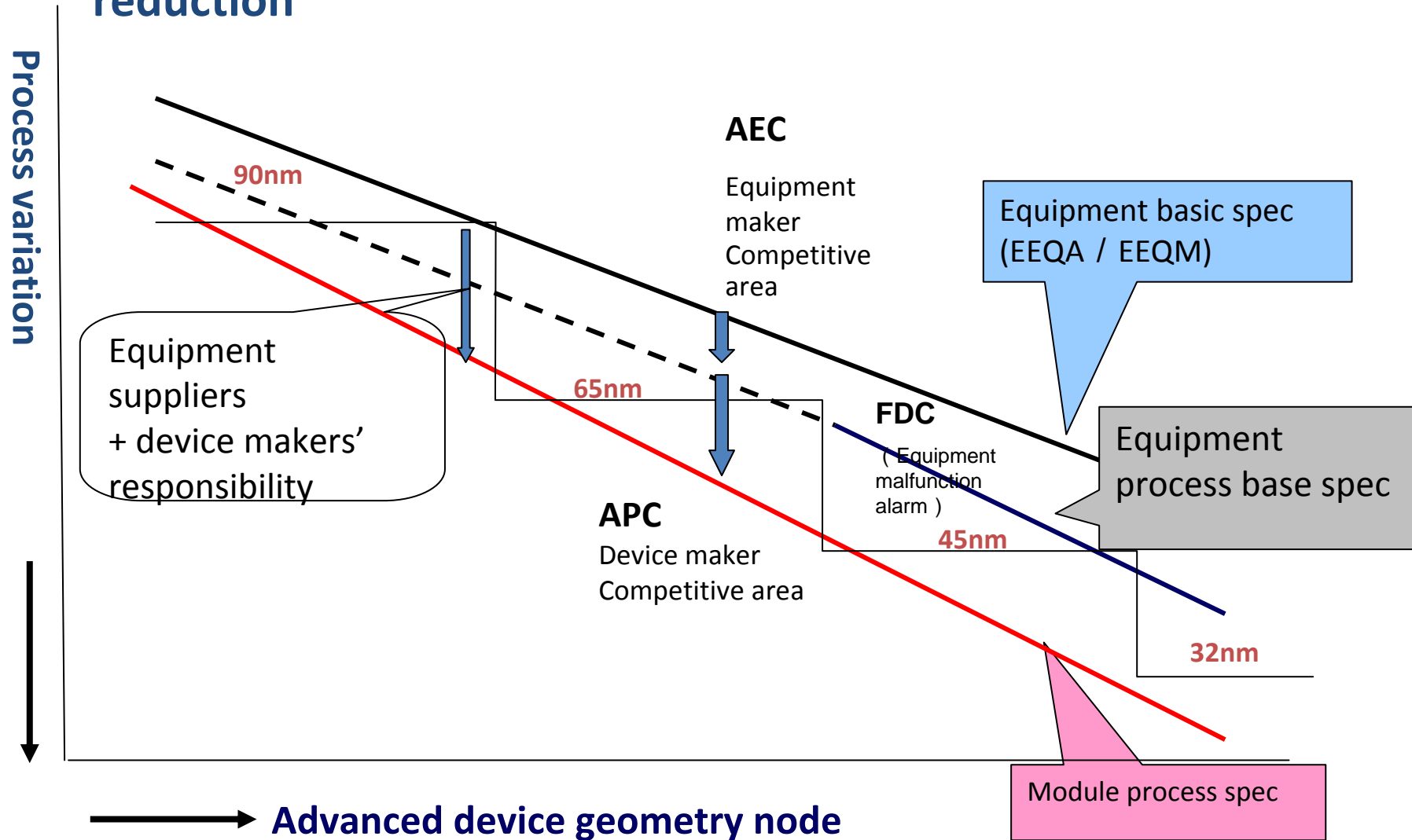
Wafer Point of View Control

Measure the processed amount and apply the necessary correction by the current process to realize device performance

- Process Variation across chip, within wafer, and within a Lot
- Variation Increase due to batch process
- Wafer surface condition change due to waiting for dispatch

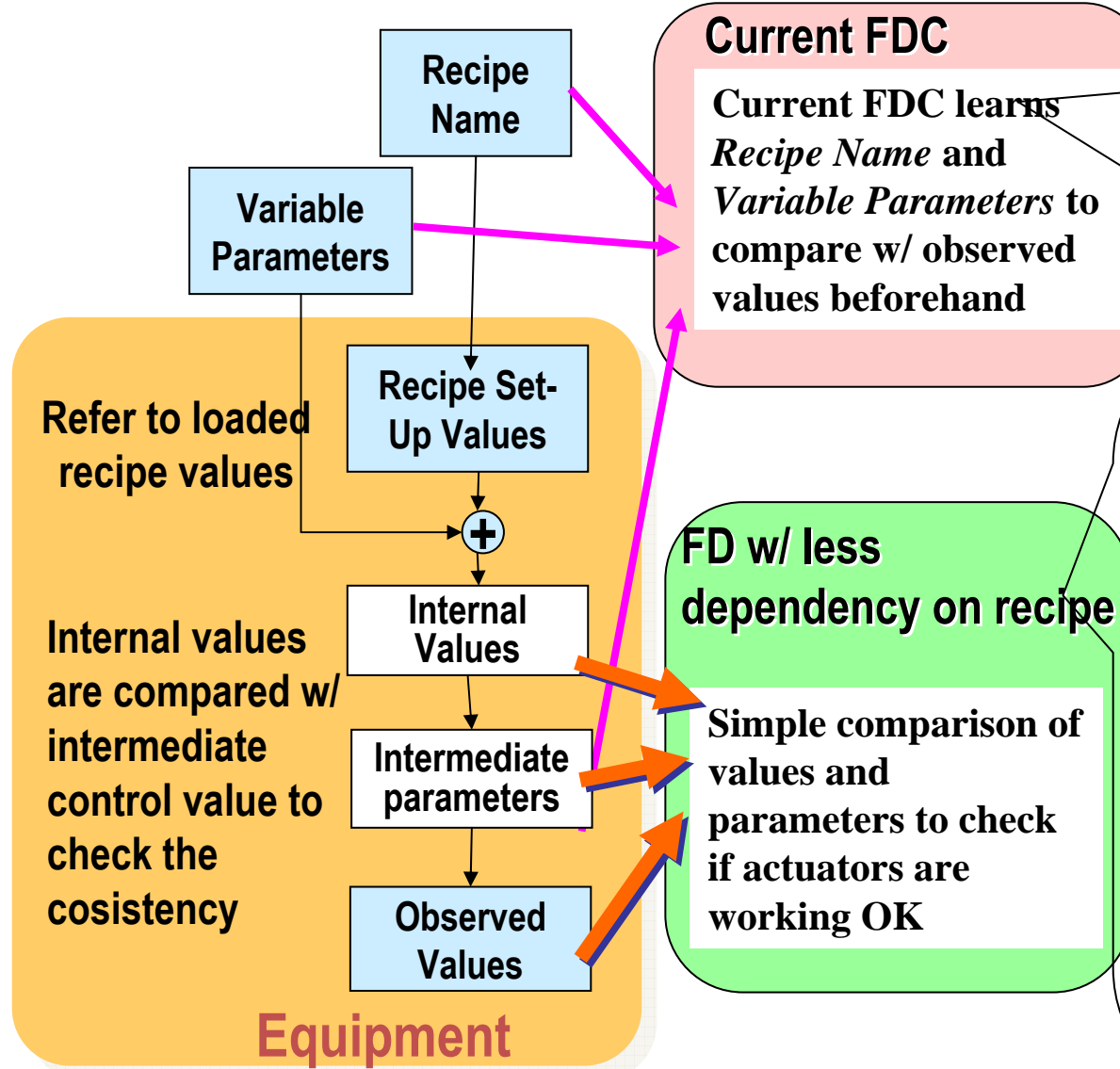


Between Device makers and equipment suppliers' information exchange is important for process variation reduction



Equipment Parts' name standardization

•New Equipment Emulator



☐ Merit

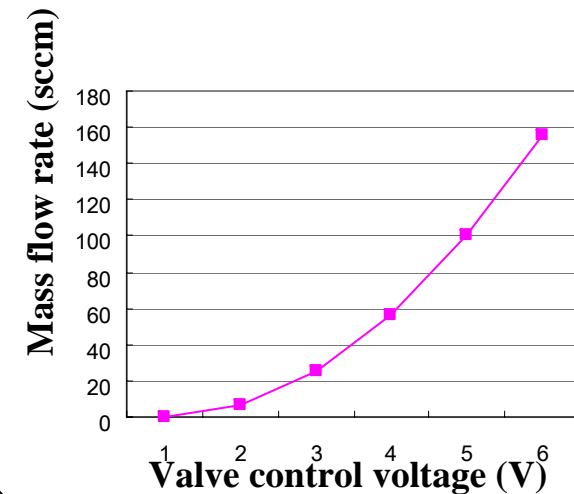
✦ Well established

☐ Demerit

✦ Frequent rule maintenance needed for high mix production

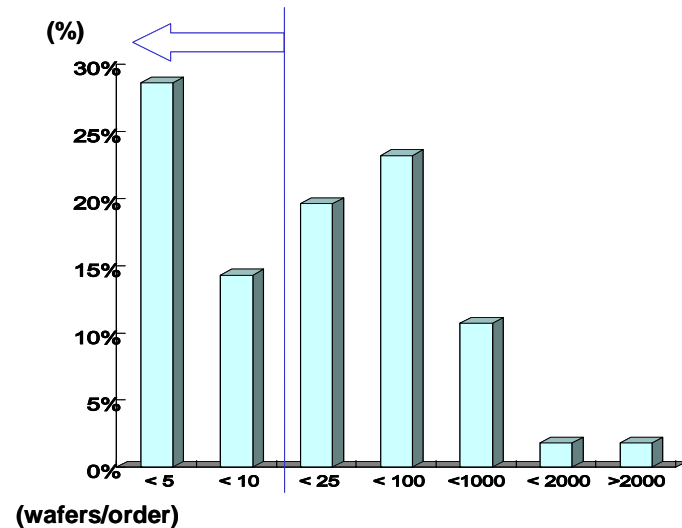
☐ Actuator behavior in near-real time manner

✦ Comparison with actuator characteristics

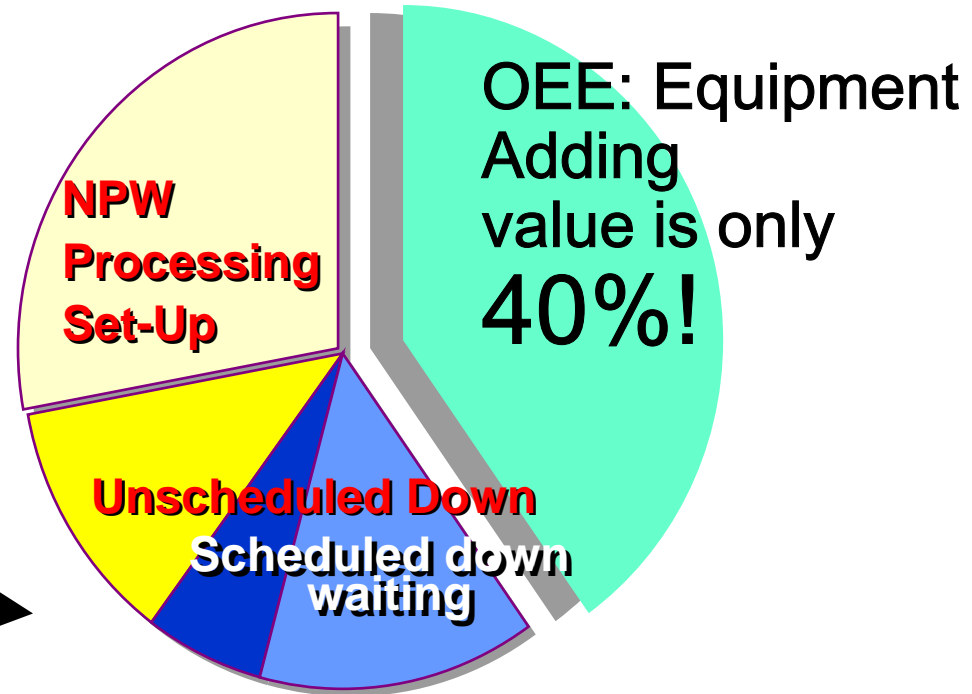


High Mix/Small Lot Manufacturing issue

Order size, lot size reduction further reduce OEE of Equipment



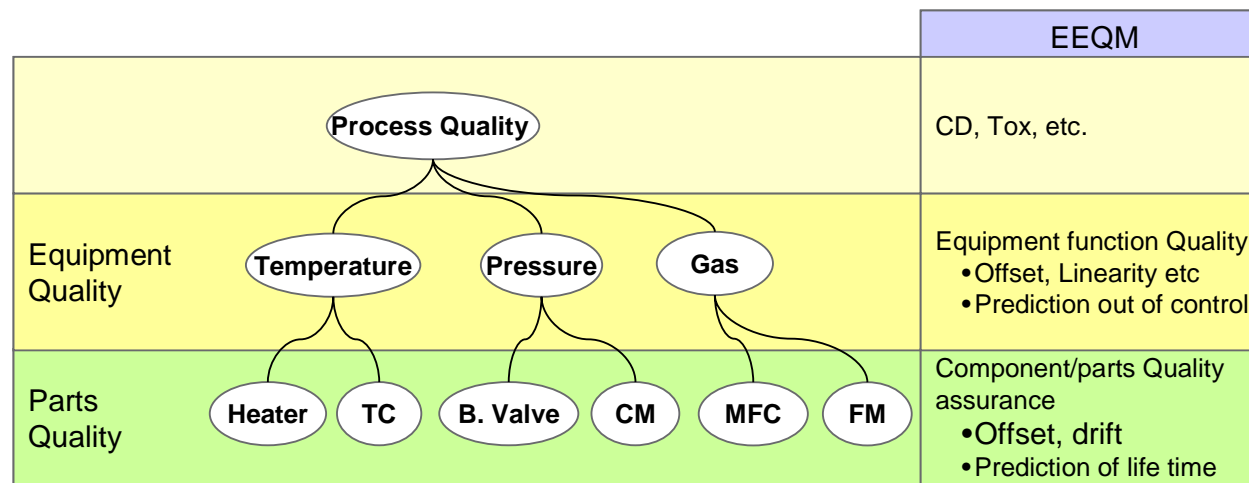
More than 40% consists of less than 10 wafers per lot



Source - SEMATECH

Hierarchical Assurance of equipment's process execution performance

Equipment's process execution performance quality (such as low failure rate, short equipment state validation time, low process outcome quality fluctuation, reduced machine-to-machine or chamber-to-chamber difference), shall be assured in accordance to equipment's hierarchical logical structure model. This quality validation shall be performed prior to equipment's acceptance to the production line by the equipment supplier. This quality assurance should be performed at needed frequency after the acceptance. The EEQA data shall be able to be shared between the equipment supplier and the device maker.



Enhanced Equipment Quality Management (EEQM)

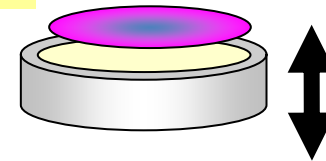
“Module-level” equipment condition setting and self-diagnostic

- Equipment self-monitoring and diagnostics
- Module-level detail quality assurance

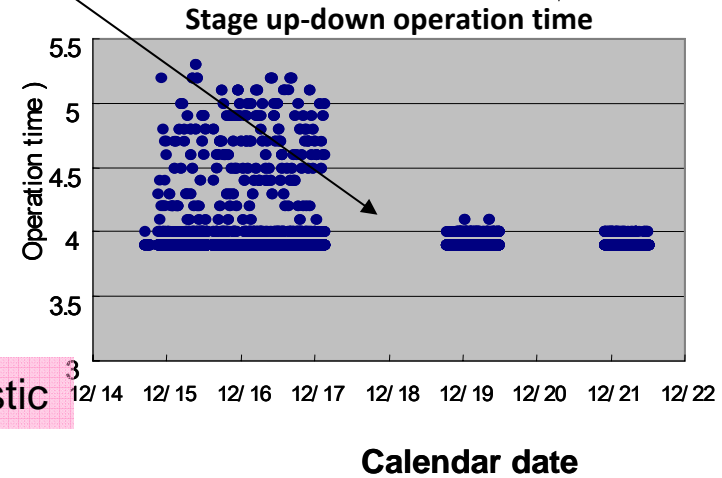
(An example of **wafer stage operation**)

**Up-down operation
time monitoring**

If operation time shows remarkable
Variability, maintenance
should be implemented.



maintenance



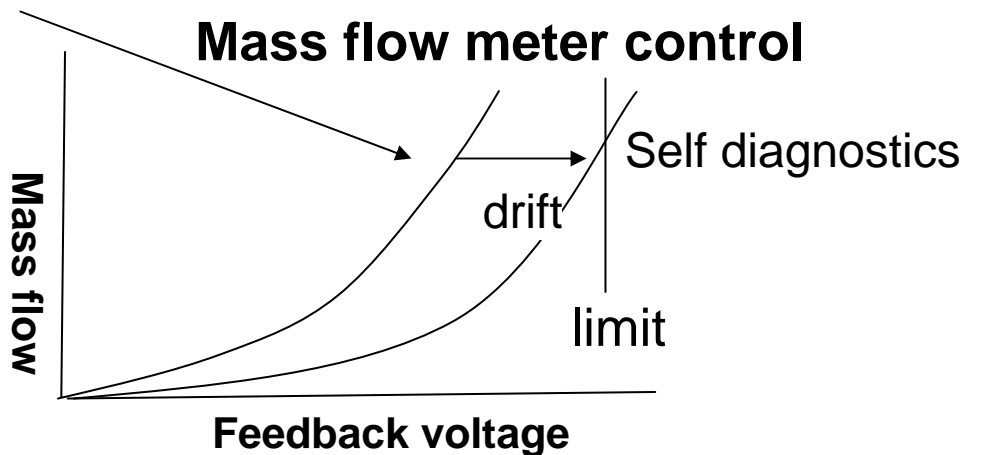
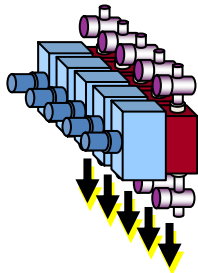
Source 2002 e-manufacturing workshop ULVAC

“Parts-level” equipment condition setting and self diagnostic

(An example of **mass flow meter**)

Offset & drift monitoring

If a relation curve drifts over the
limit, a mass flow meter will be
replaced before breakdown.

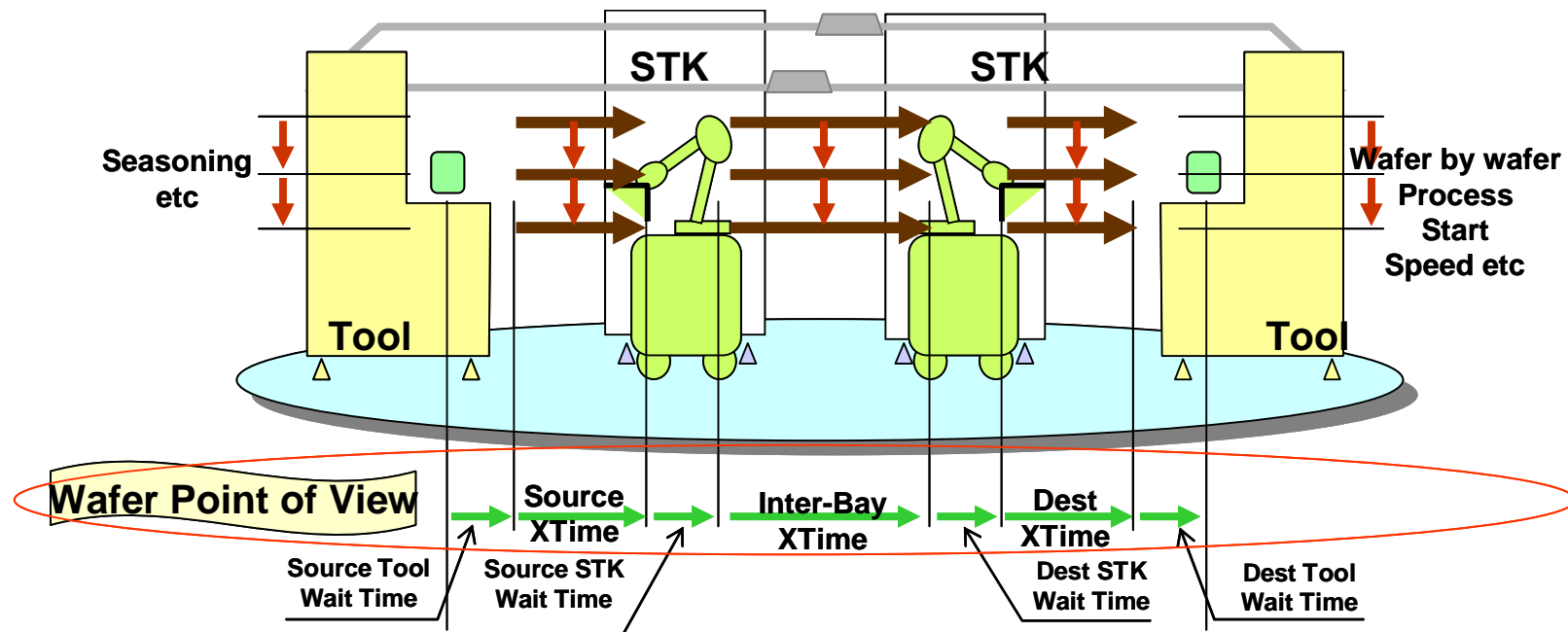


Data for Equipment Visualization (EXAMPLE)

1	MES instruction information and factory control events per SEMI standard (GEM300)	
2	Load port and/or EFEM activity events	
3	Wafer movement related events	
4	Process recipe step events	
5	Principal process actuator activity data	Control instruction issuance events and relevant context data
		Behind the scene activity (servo feedback control data such as heater power, APC valve angle,..)
		Instruction values to process actuators
		Observed process parameters generated
6	Various equipment constants (time constants, coefficients, ...)	
7	Related human activity signature (panel manipulation, maintenance related events such as atom switch, chamber door opening,...)	
8	Equipment status and their change events for OEE calculation, energy and material consumption, ...	

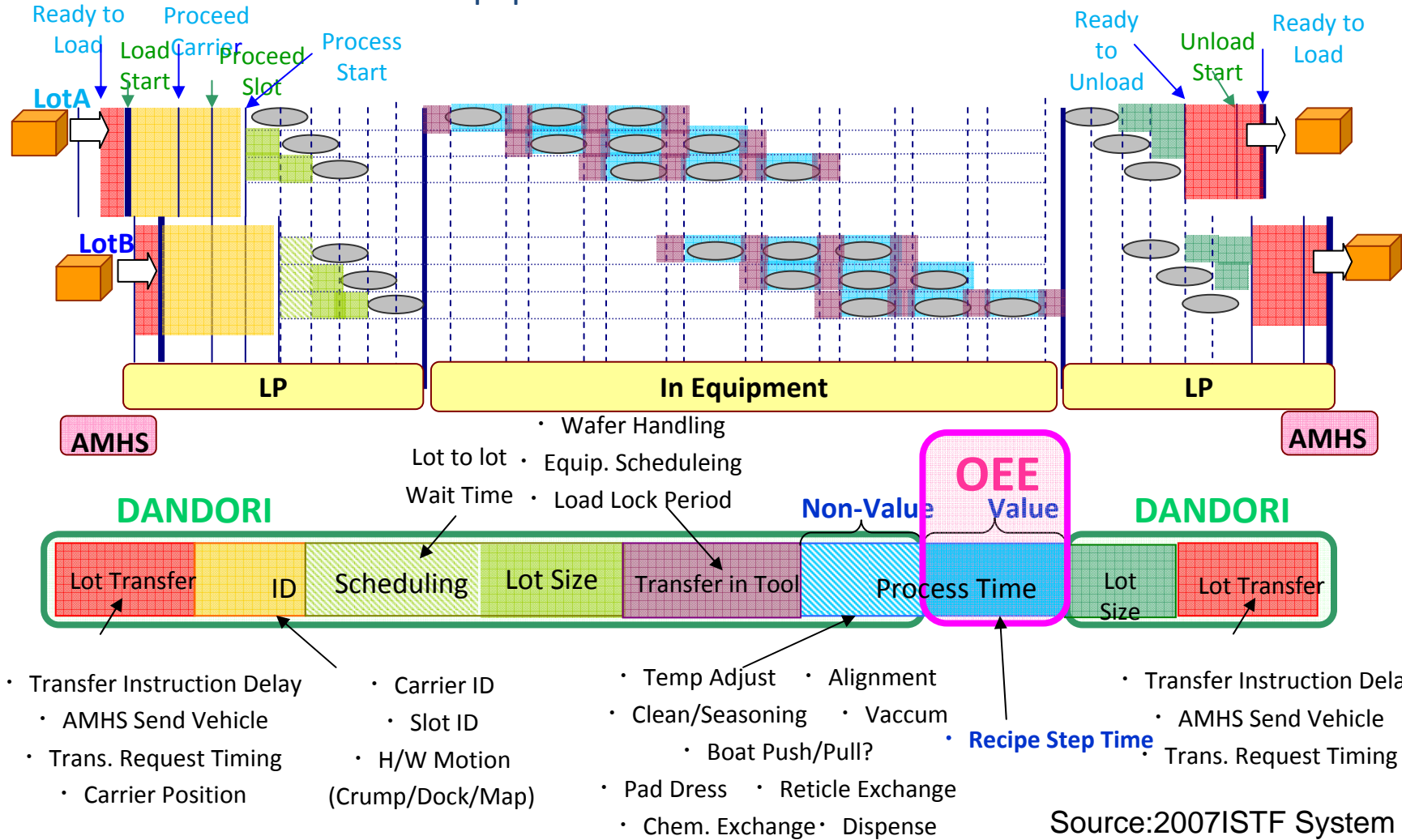
Definition of Dandori

Dandori operations are peripheral operations to the throughput-constraint main thread operations. Dandori operations include preparatory operations before the processing, post process operations, wafer transportation, wafer identification operation.



DANDORI ? Wafer point of view

Predictive equipment information can reduce Dandori

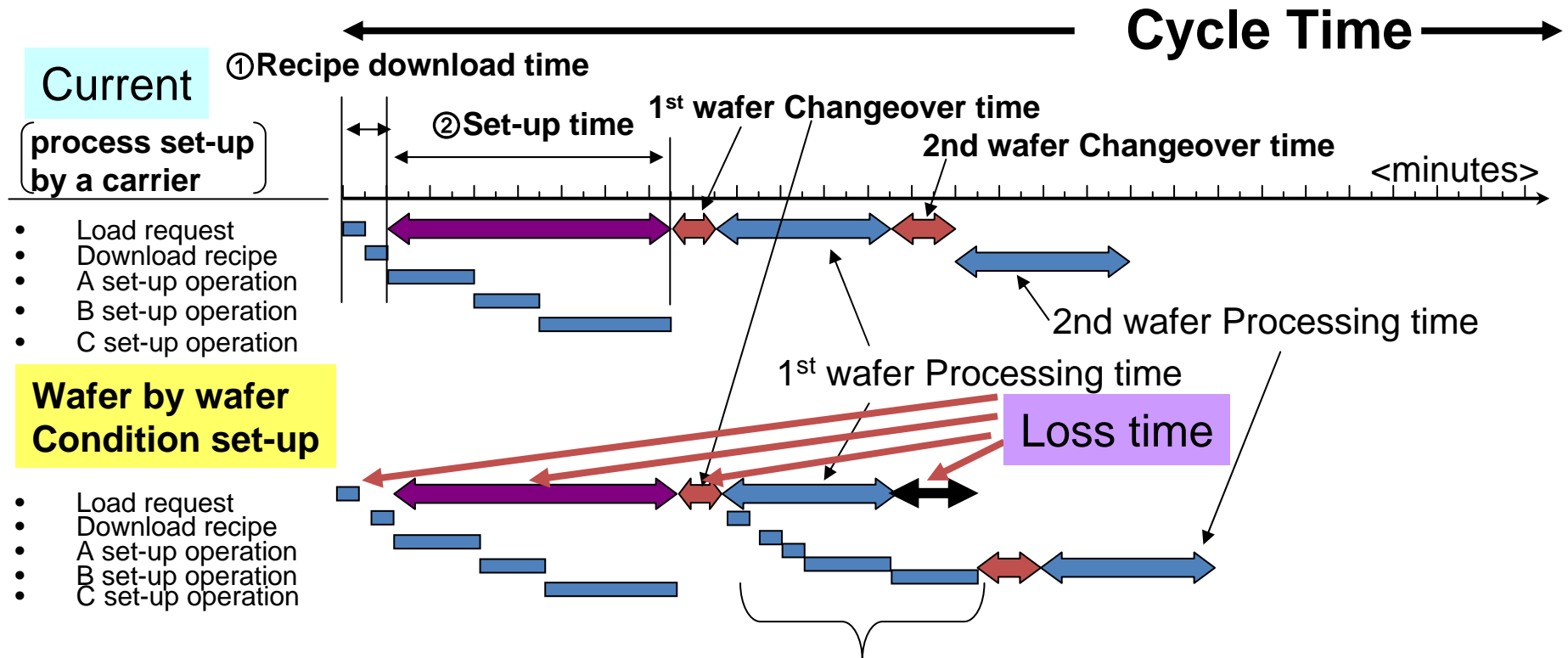


Source:2007ISTF System V

Recipe Download and Setting

Wafer by wafer condition set-up;

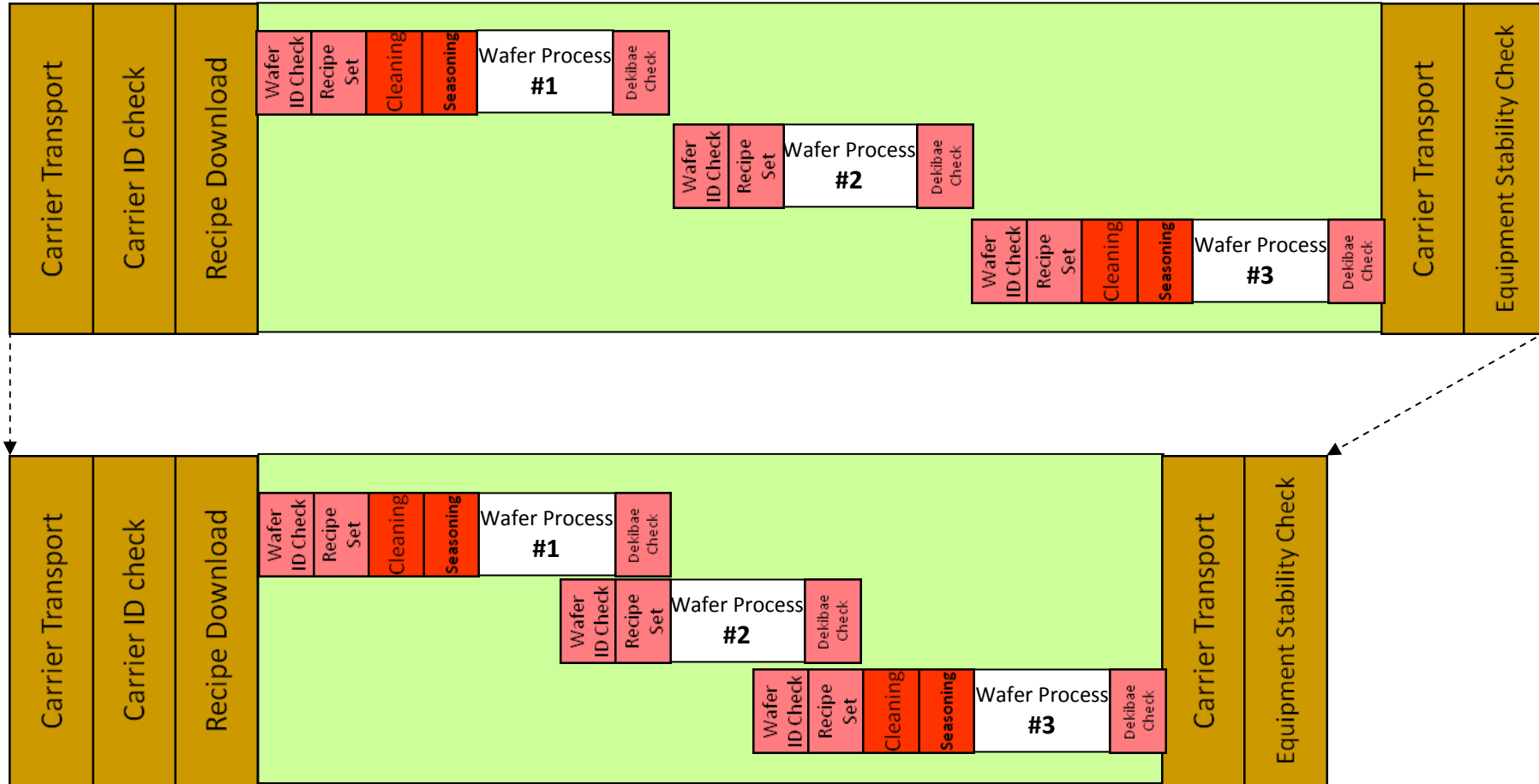
Recipe download and set-up time must be reduced



load request, wafer ID check, wafer-level APC, recipe download, wafer-level set-up

Waste Reduction

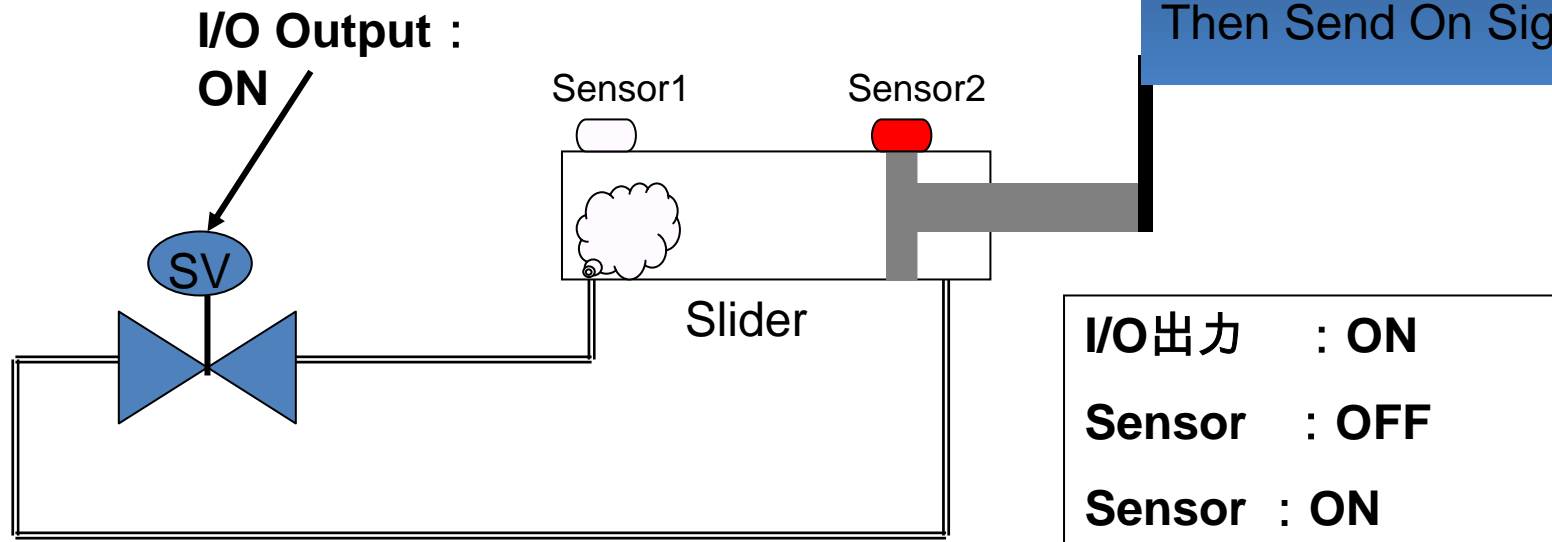
Equipment level



Waste reduction

Parts level

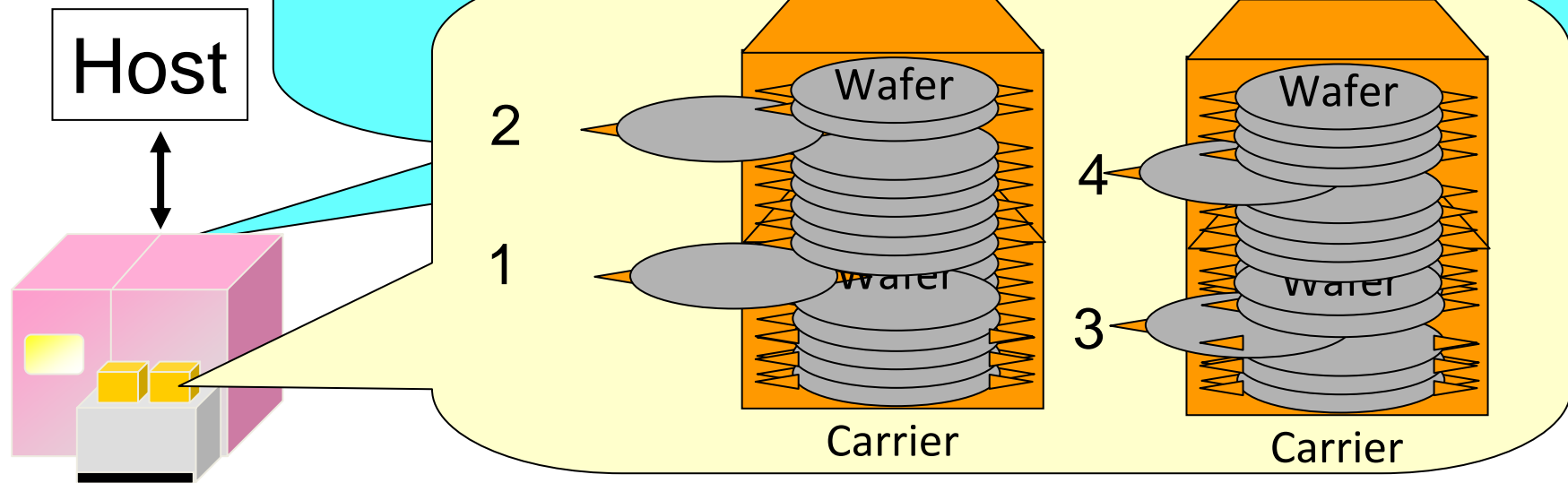
Clear Definition is necessary
for Dandori Reduction.



Wafer control/Equipment control interface

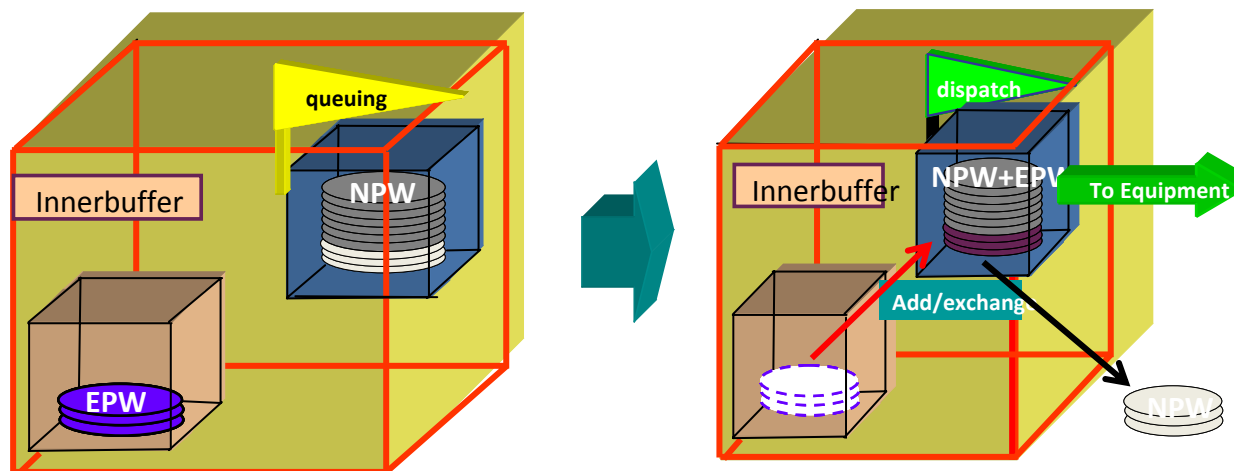
Equipment's wafer processing order and Dandori order shall be controlled by the factory system.

Cleaning timing, seasoning timing, maintenance timing, target exchange timing, chronicle performance variation correction, etc

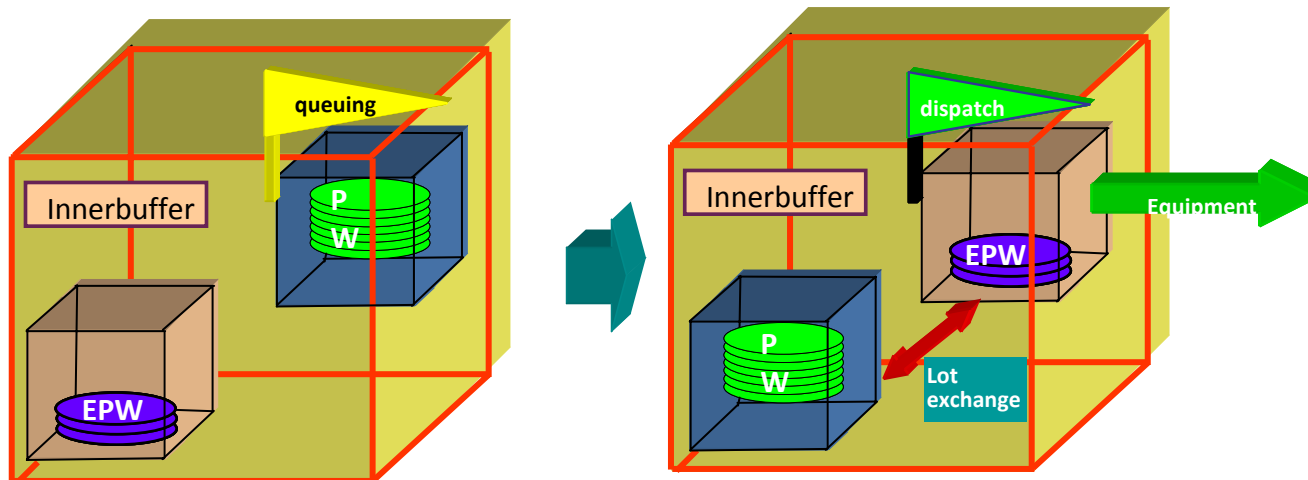
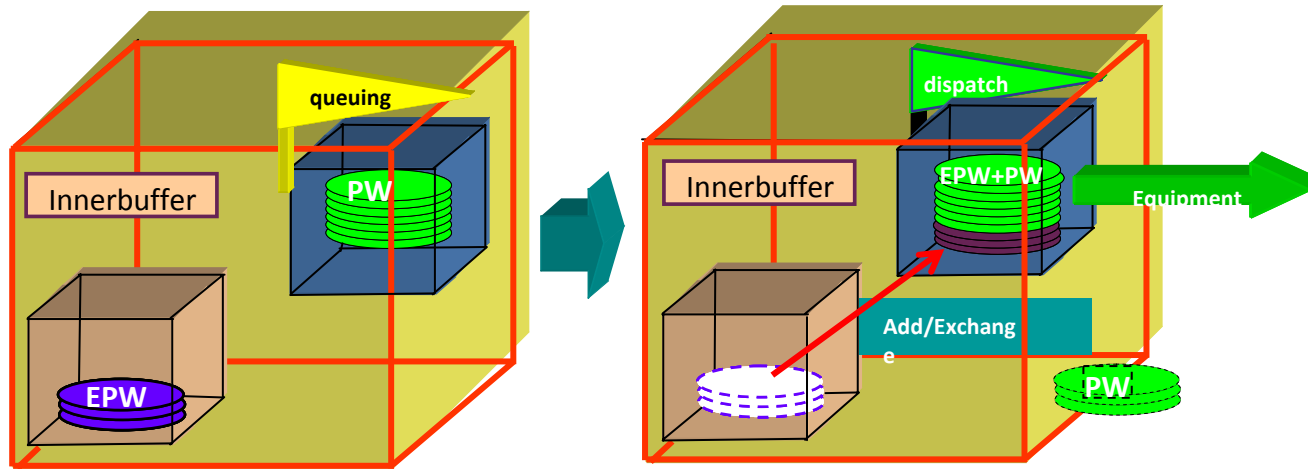


Wafer overtaking in Batch Equipment

- Batch process equipment with the internal buffer shall be capable of accepting *hot wafers* until the reserved process is started by the instruction from the factory system.
- **Background/purpose:** Batch equipment such as oxidation/diffusion, cleaning, and low pressure-CVD is one of the biggest obstacles to achieve reduction of hot wafer's cycle time. Operations below would enable reduction of hot wafer's cycle time. This would be a large positive impact to SoC business.
- In the case where reserved *fill-dummy wafers* for the scheduled batch can be replaced with *hot wafers*, new process starts after batch formation is repeated for the new set of wafers.



In the case where product wafers for the scheduled batch can be replaced with *hot wafers* or where *hot wafers* can be simply added to the scheduled batch, the new process starts after batch formation is repeated for the new set of wafers.



Current and future equipment control standards

	current	future
Control object	Lot (partly wafer)	Wafer, Equipment, Material
Operation order	Slot by slot	Wafer by wafer Dandori (slot free)
Information Data	GEM300 Data	GEM300P Structured Data
Standard	E40(PJM), E87(CMS), E90(STS), E94(CJM)	New Standards

W1234 : WaferClass

```

+Id :String
+onProcess : String
+measuredData :
Double
+position : String

+selectData()
+storeData()
-modelData()
-reuseData()
    
```

Conclusion

- Pro-visualization is necessary for equipment's multi-dimensional improvements. The first step is equipment's name standardization, which helps its structural understanding and solving many issues.
- New standard like GEM300Prime is required, which materials wafer and equipment objects' smooth waste-less communication in factory information system.