

Establishing Data Quality Standards and Test Methods

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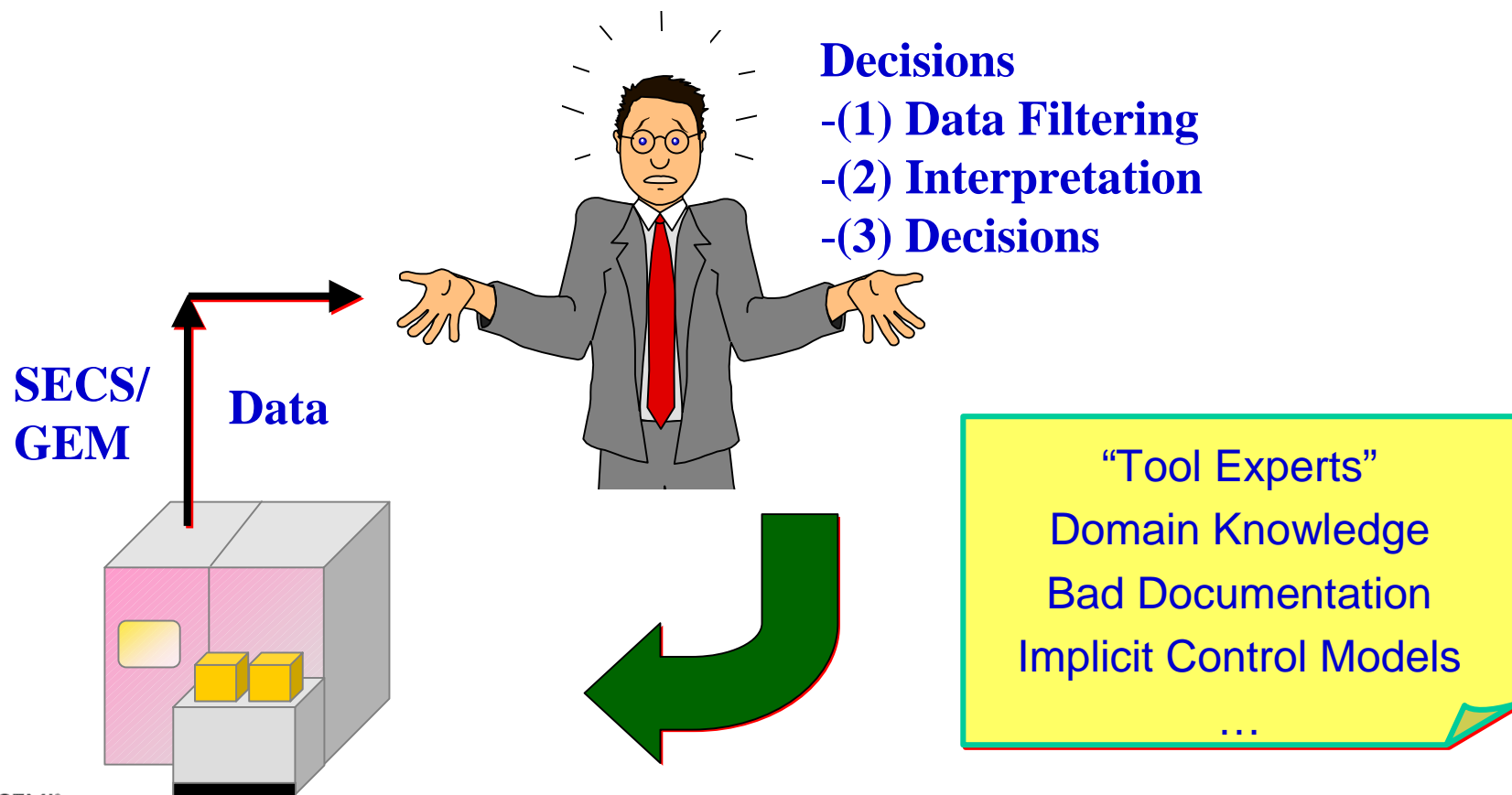


Outline

- ➔ • Introduction
 - Scope
 - Importance
- Results
 - International SEMATECH Data Quality Project
 - SEMI Data Quality Task Force
- Summary

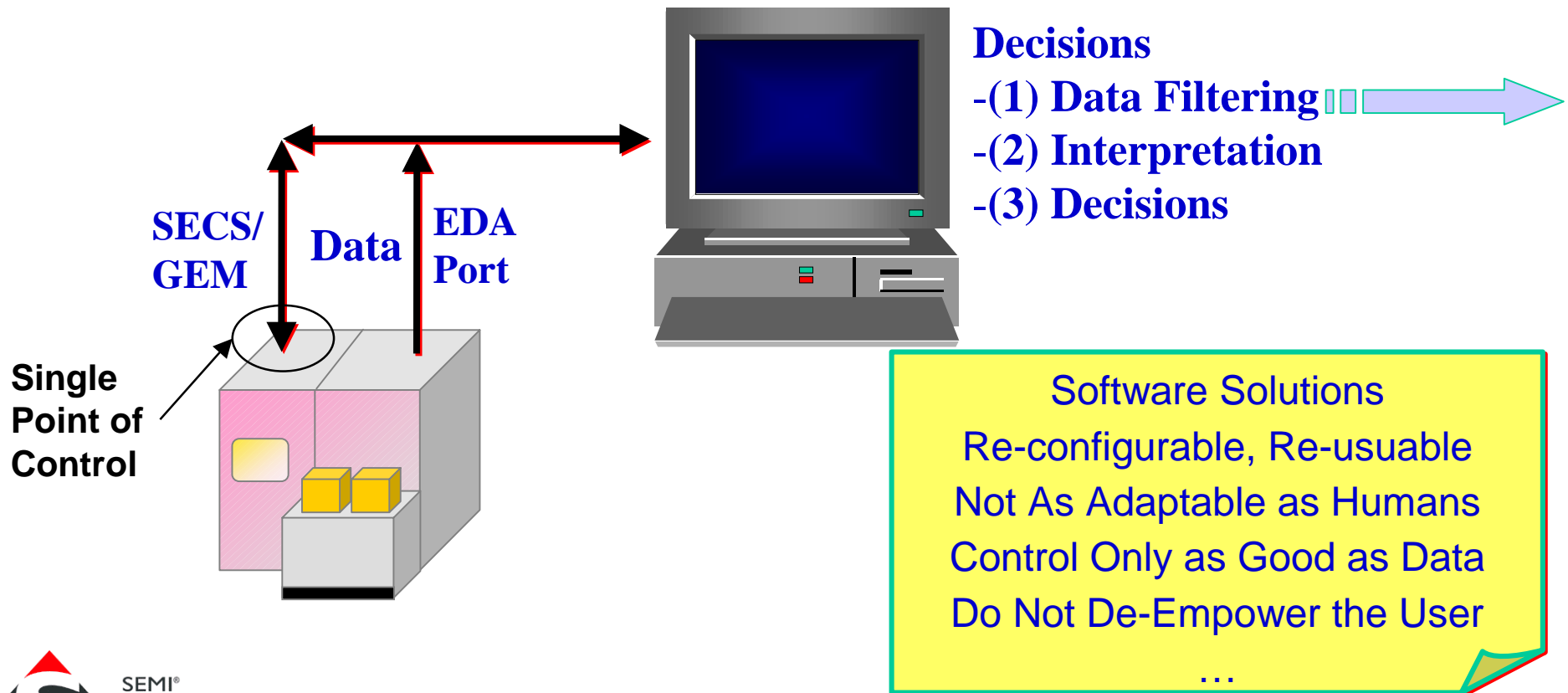
Introduction

- In the **Past**, humans interpreted tool output
 - Complex and very adaptable minds



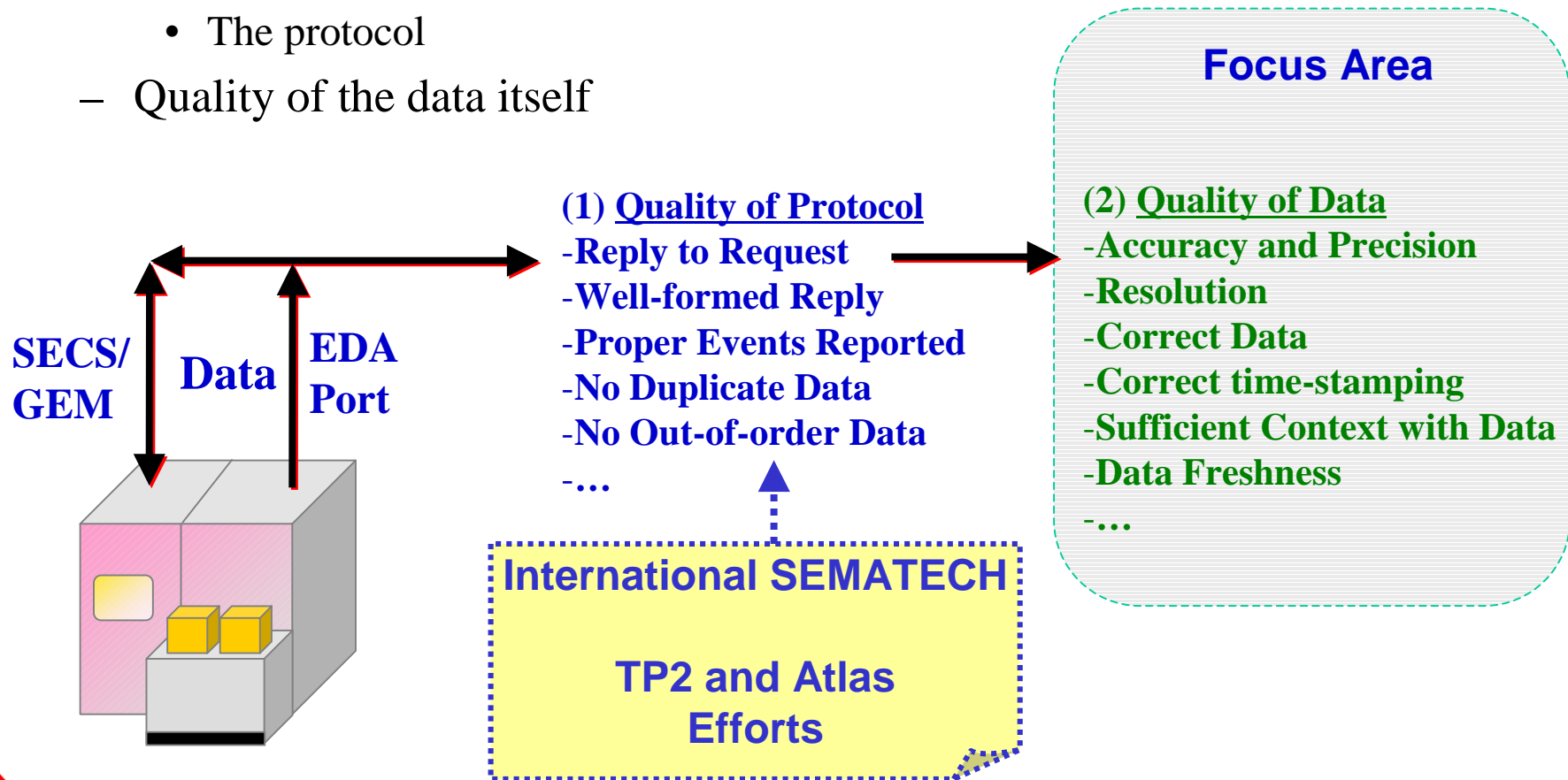
Introduction

- We are moving towards automated data filtering, interpretation and control
 - Fast, but not as adaptable



Introduction

- Data filtering
 - Quality of reporting of data
 - The protocol
 - Quality of the data itself

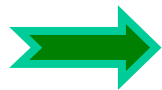


Motivation

- **Importance of Data Quality**
 - Move toward data driven fab productivity and automation \pm more decisions made on the data
 - Need for language to support dialogue between users / OEMs / suppliers
 - e-Manufacturing solutions
 - Quality of data is critical to Quality of Service (QoS) provided by applications
 - Bad data is worse than no data at all
 - **If we wait until the e-Diagnostics infrastructure is in place before we realize how bad the data can be, then we are in trouble...**

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ISMT: Data Quality—Phase I

- Project scope
 - September 2002 – March 2003
 - Brooks Automation
- Deliverables
 - **Data Quality Definitions, Capabilities and Metrics**
 - **Data Quality Test Methods**
 - **Data Quality Standard Effort**
 - **Data Quality Tutorial**
 - **First Data Quality test solution**
 - **Enhancement of Brooks Automation Envoy software**
 - **Testing data out of the SECS/GEM port**
 - **ISMT member company as first Data Quality test customer**
 - **Test report being transferred**

Results: DQ Test Solution

- Software Tester Solution Structure (SECS/GEM Interface DQ Testing)
 - Design for delivering results today
 - OEM provides specification on existence and resolution of variables (SVIDs)
 - Statement of Conformance (SoC) Sheet
 - Tester asks for these SVIDs
 - Static mode: while tool is not operating
 - Dynamic mode: Trigger determines when SVIDs are “Valid”
 - SVIDs are evaluated against minimum, maximum, resolution and Triggering Capability
 - Results ↯ Database log file
 - Log file ↯ Conformance Results Report

DQ Conformance Test Solution

Table 1: Data Quality Statement of Conformance (SoC) Data Sheet

#	SVID	Name	Units	Definition	Availability and Validity	Bit Resolution	Min Value	Max Value
1								
2								
...								
n								

SVID—SECS SVID for the variable.

Name—Name for the variable that has meaning to a tool engineer.

Units—Units of measurement for the variable, if applicable.

Definition—A definition of what the variable represents; this could include definition of how the variable is measured and when it is valid.

Availability and Validity—An indication of when the SVID is available for retrieval, and when the retrieved value can be assumed to be valid; this can be expressed in terms of process states, recipe steps, etc.

Bit Resolution—The bit resolution of the SVID; note that this does not have to be consistent with the actual resolution of the SVID, however this quality is of course encouraged.

Min Value—The minimum range value of the SVID when it is valid.

Max Value—The maximum range value of the SVID when it is valid.

**Important
Communication Tool
(Vendor & User)**

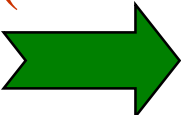
**Later & Electronic
Data Sheets
(XML Metadata)**

Data Quality Testing — 300mm Wafer Processing Tool

Example of Test Results

- Utilized tool SECS/GEM documentation to determine SVID information initially
- SVID focus
 - Tool Vendor #2 has a standard set of SVID's
 - 11 SVID's were collected from a total of over 350 SVIDs
 - Attempt made to collect SVID's while tool was idle and operating

Data Quality Testing — 300mm Wafer Processing Tool *Observations*

- Documentation: “Name” for SVID’s is just listed as “Process Data XX”
 - You have to look at the “Description” column for the actual meaningful name of the SVID \mathbb{E} We think this is a bad practice
- You cannot monitor key in-situ sensors such as temperature and endpoint time
 - These sensors are fully integrated into the tool \mathbb{E} should be available at the SECS/GEM interface
 - \mathbb{E} Data availability problem to support R2R Control and FDC
- S1 F11 Works, but doesn’t return units for any SVID’s (it is available in the manual though) 
 - Three of the SVID’s in the S1 F12 response have no name

- S1 F11 Issue Continued:

```

- <L [3]
-   <U4 [/1]    41>
-   <A [/1] 'GemTime'>
-   <A [/1] 's'>
- >
- <L [3]
-   <U4 [/1]    81>
-   <A [/1] ">
-   <A [/1] ">
- >
- <L [3]
-   <U4 [/1]    82>
-   <A [/1] ">
-   <A [/1] ">
- >
- <L [3]
-   <U4 [/1]    83>
-   <A [/1] ">
-   <A [/1] ">
- >
- <L [3]
-   <U4 [/1]    216>
-   <A [/1] 'SubstLoc1'>
-   <A [/1] ">
  
```

Data Quality
Test Software
Output

Name and
Units Reported

No Name or
Units Reported

Name Reported,
no units inferred

Note that there
are multiple
failure modes

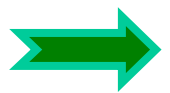
Data Quality Testing — 300mm Wafer Processing Tool

Observations Continued

- This tool does **NOT** report process variable actual values
 - It reports values of zero across the board when these variables in-fact are often non-zero!
 - This may be due to the tool not being in a process state or it doesn't report actual values in any state
 - **Either case is a serious data quality issue**
- The tool repeatedly went into an interlock error condition when we tried to run wafers (3 separate times), therefore we were unable to completely run the dynamic test

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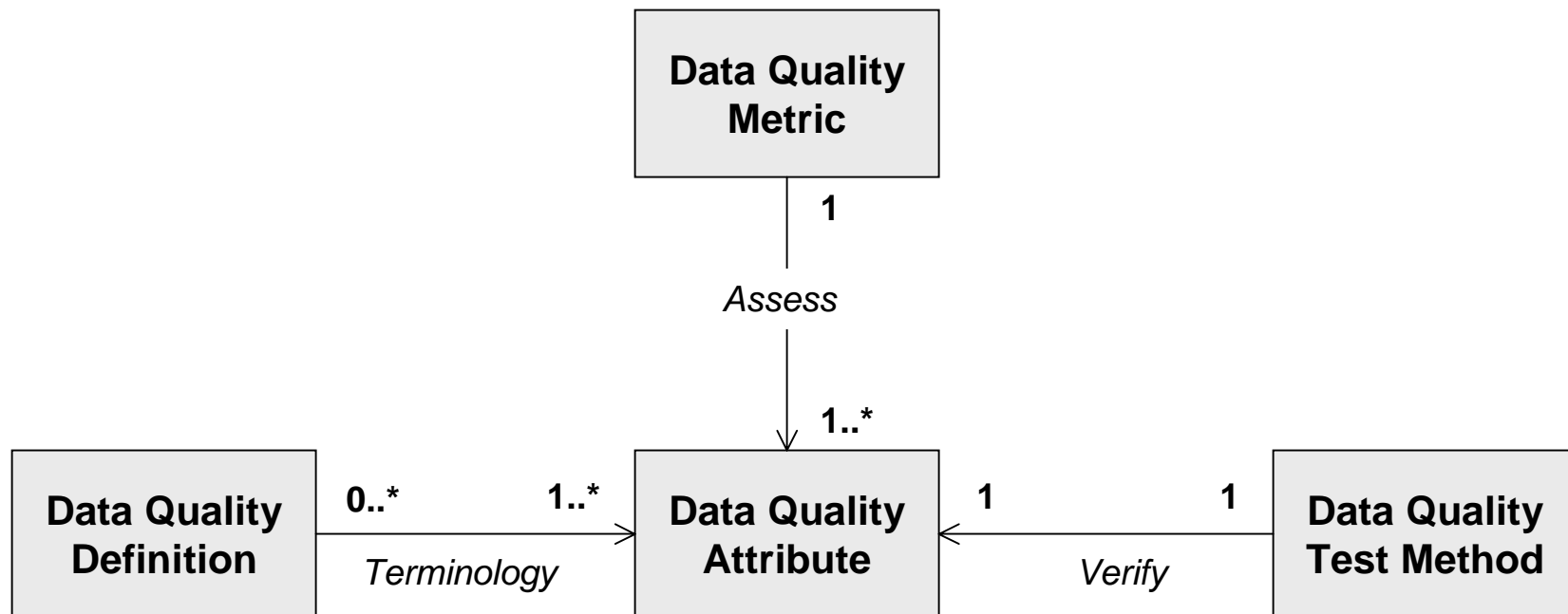
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SEMI Efforts in Data Quality

- Data Quality Test Methods SEMI Task Force (DQ-TF)
 - Under Information and Control Committee (NA-I&CC)
 - Formed at SEMICON/West 2002
 - Leadership
 - James Moyne: Brooks Automation
 - John Pace: SI Automation
 - Brad Van Eck: International SEMATECH
 - ➔ – **Scope**
 - **Data quality definitions and metrics**
 - **Data for control and diagnostics**
 - **Data quality and communication test methods (later)**

Data Quality Standard—Approach

- Focusing initially on the “data availability” data quality attribute



Data Quality Standard Status

- Blue Ballot in Preparation
 - Provisional Standard
 - Focus on Data Availability attribute
 - Standardizing the entire process
 - Definitions, Attributes, Metrics, and Test Methods
 - ↳ Data Quality Capabilities
 - ISMT project as input
- Yellow Ballot preparation later in 2003

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Summary

- Data quality is an overlooked pre-requisite to e-Manufacturing
- Data quality of many tool interfaces today is poor
 - Insufficient to support e-Diagnostics
- There are two significant efforts in data quality
 - SEMI \mathcal{E} DQ test methodologies
 - Blue ballot in preparation
 - International SEMATECH Effort \mathcal{E} DQ Test Solutions
 - Phase I completed
 - Phase II DQ test product?