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Practical Applications of the ISA 95 standard

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BR&L Consulting

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MESA*KNOWS*

SUSTAINABILITY & ECO-EFFICIENCY - LEAN - METRICS & PERFORMANCE MANAGEMENT
INFORMATION INTEGRATION - SAFETY - ASSET PERFORMANCE MANAGEMENT - B2MML
QUALITY & COMPLIANCE - PRODUCT LIFECYCLE MANAGEMENT - AUTOMATION

Do you know MESA?

Dennis Brandl

- Dennis Brandl has been an active member of ISA's SP88 Batch Control System committee since 1990, a U.S. expert in batch control to IEC, editor of the ISA95 Enterprise-Control System Integration standard, and convener of the IEC SC65E JWG 5 working group.
- He has been involved in automation system design and implementation for the past 30 years including Apollo and Space Shuttle test systems for Rockwell Space Division, as well as work with Shell Oil, Texas Instruments, Siemens, Square D, Sequencia, Telemecanique, Modicon, Pfizer, Lilly, Merck, GSK, Genentech, P&G, DOW, and other process industry companies.
- Dennis has a B.S. in Physics, an M.S. in Measurement and Control from Carnegie Mellon University, and an M.S. in Computer Science from California State University.

Agenda

- Introduction to ISA 95 & MES
- Advantages of the ISA95 standard
- Most important models of ISA95
- Practical applicability of the ISA95 models for end users, consultants and engineers
- Practical examples and descriptions of typical application structures
- Questions and answers

What is ISA 95

- USA ANSI standard developed by an ISA Committee of volunteer experts

- **ANSI/ISA 95.01 ed2** "Enterprise - Control System Integration – Part 1: Models and Terminology"
- **ANSI-ISA 95.02 ed2** "Enterprise - Control System Integration – Part 2: Objects and Attributes"
- **ANSI/ISA 95.03 ed2** "Enterprise - Control System Integration – Part 3: Models of Manufacturing Operations"
- **ANSI/ISA 95.04 ed1** "Enterprise - Control System Integration – Part 4: Objects and attributes for manufacturing operations management integration"
- **ANSI/ISA 95.05 ed3** "Enterprise - Control System Integration – Business to Manufacturing Transactions

- Also available as **IEC/ISO 62264** standards

A Bit Of History

- **Prior to ISA 95**
  - MES was not a well defined area, slow growth in deployments
  - MES was sometime viewed as a solution in search of a problem
  - Hard to integrate with business level systems and shop floor control
  - Very, very, very industry specific
  - No common definitions or terminology
- **After ISA 95**
  - Redefined MES as MOM (Manufacturing Operation Management)
  - MOM activities are well defined
  - Standard definitions and terminology, common requirements
  - Well understood and supported business level to ship floor control integration
  - More cross-industry solutions becoming available
  - Significant competition and advances in solutions
  - Rapid growth in deployments

Example Benefits from MES/MOM*

Benefit Category	Range of Benefits	Reduction Range
Document Review Approval (SOPs)	$100,000 - $3 Million	10% - 80%
Batch Record Preparation & Handling	$11,000 - $1.3 Million	40% - 80%
Batch Record Review	$115,000 - $1.0 Million	40% - 80%
Data Entry & Calculations	$20,000 - $4.6 Million	40% - 90%
Deviations	$6,000 - $1.3 Million	25% - 60%
Logbook Handling	$7,000 – $105,000	25% - 80%
Material Losses	Value of preventable discards	30% - 60%
Testing	Preventable deviations testing	30% - 50%
Inventory Carrying Costs	Reduced Inventory Carrying	
Throughput	$value of additional batches	
RANGE OF TOTAL ANNUAL BENEFITS	**$450,000 - >$10 Million**	

* CBINet Conference, INDUSTRY BEST PRACTICES FOR MES ARCHITECTURE, August 2009, *Key Considerations for MES Project Planning and Execution*, Michalle Adkins and Paul Brandenburg (Lilly)

The Advantages of the ISA 95 Standard

- Common terminology and definition of functions
  - Simplifies writing requirements for end-users
  - Simplified vendor understanding of end-user requirements
- Integration of ERP with MES/MOM systems
  - Prior to ISA 95, projects took 1-2 years & <50% successful
  - After ISA 95, projects take 2-4 months & >90% successful
- Definition of MES/MOM systems
  - Prior to ISA 95, specification took years to reach agreement
  - After ISA 95, typical specifications complete in < 6 months
  - Possible to compare different vendor solutions
    - Better match to requirements
  - Possible to compare different facilities

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Most Important ISA 95 Models

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INFORMATION INTEGRATION - SAFETY - ASSET PERFORMANCE MANAGEMENT - B2MML
QUALITY & COMPLIANCE - PRODUCT LIFECYCLE MANAGEMENT - AUTOMATION

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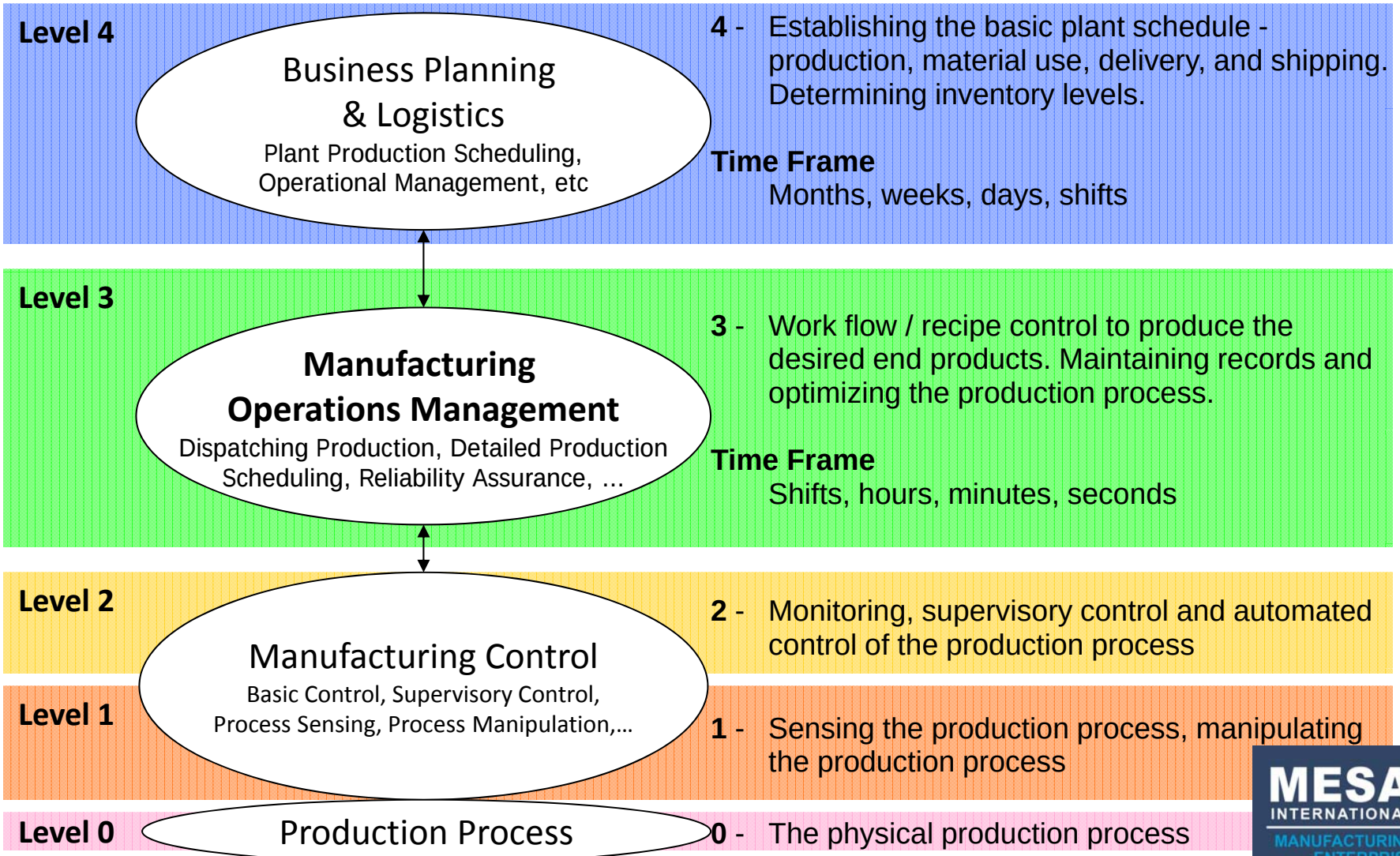
Levels and Functions



The power of knowing what **MESA***KNOWS*

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ISA95 Domain Definitions

- Provides a method to answer the question;

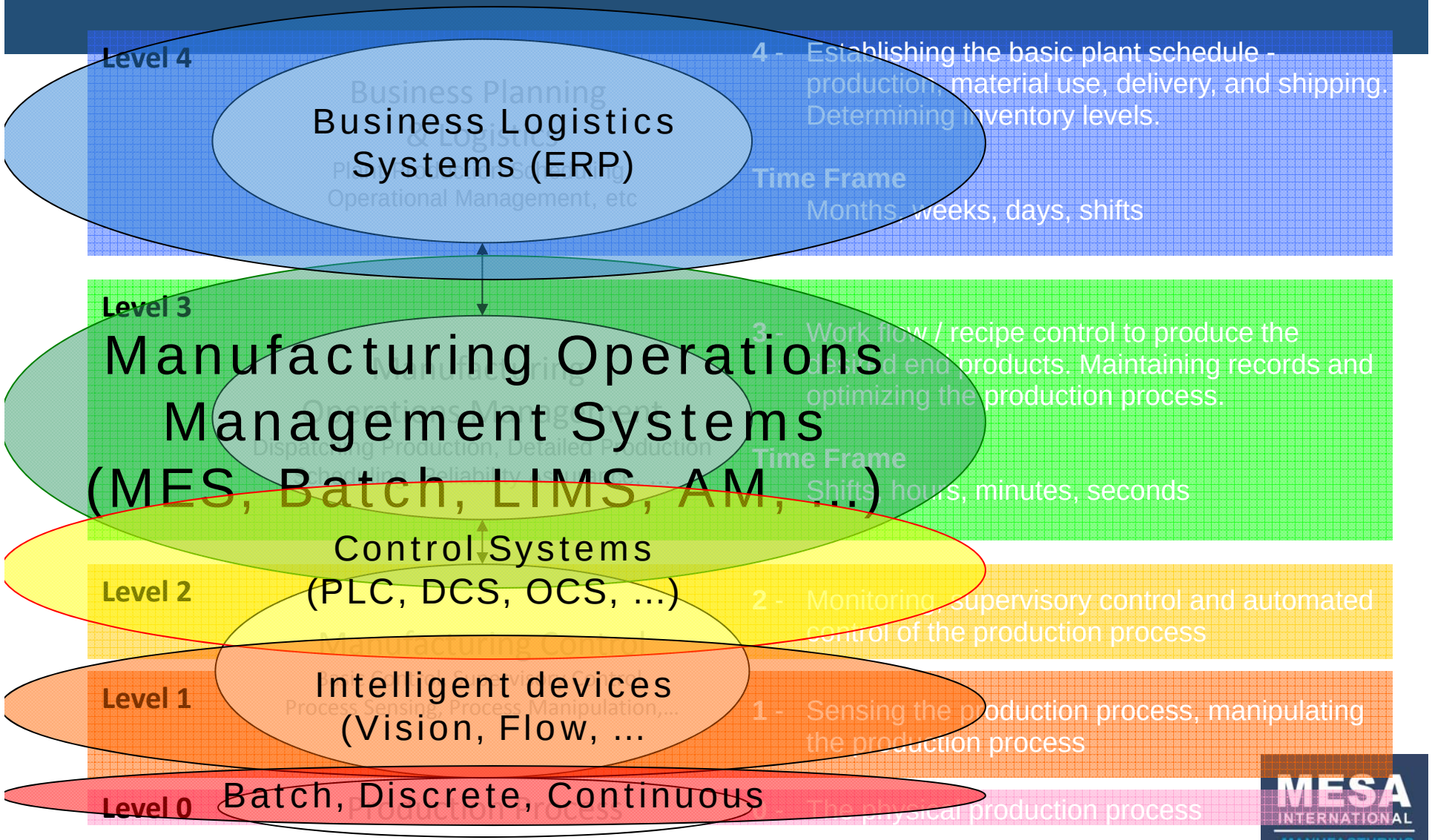
"What is in logistics
and
what is in operations ?"

- What is in Level 4 or Level 1-2-3?

Criteria for Level 3,2,1

- Activities to be included in Level 3, 2, or 1 are directly involved in manufacturing and includes information about personnel, equipment, or material and meets any of the following conditions.
  - The activity is critical to plant safety.
  - The activity is critical to plant reliability.
  - The activity is critical to plant efficiency.
    - NOTE: Absolute plant efficiencies may be dependent upon factors that are outside the control of a facility (MRP schedules, product mixes, etc.).
  - The activity is critical to product quality.
  - The activity is critical to maintaining regulatory compliance.
    - EXAMPLE: Maintaining regional, government and other agency compliance related to products and production.
    - NOTE: This includes such factors as safety, environmental and cGMP (current good manufacturing practices) compliance.
  - NOTE: There are other criteria such as company policy and organizational structure, or the nature of the operations that could expand the scope of manufacturing operations management.
  - NOTE: Such activities as personnel management of salaries and job titles may be important for running a manufacturing business, but they are not considered part of manufacturing operations management.

Level Overlap with Systems



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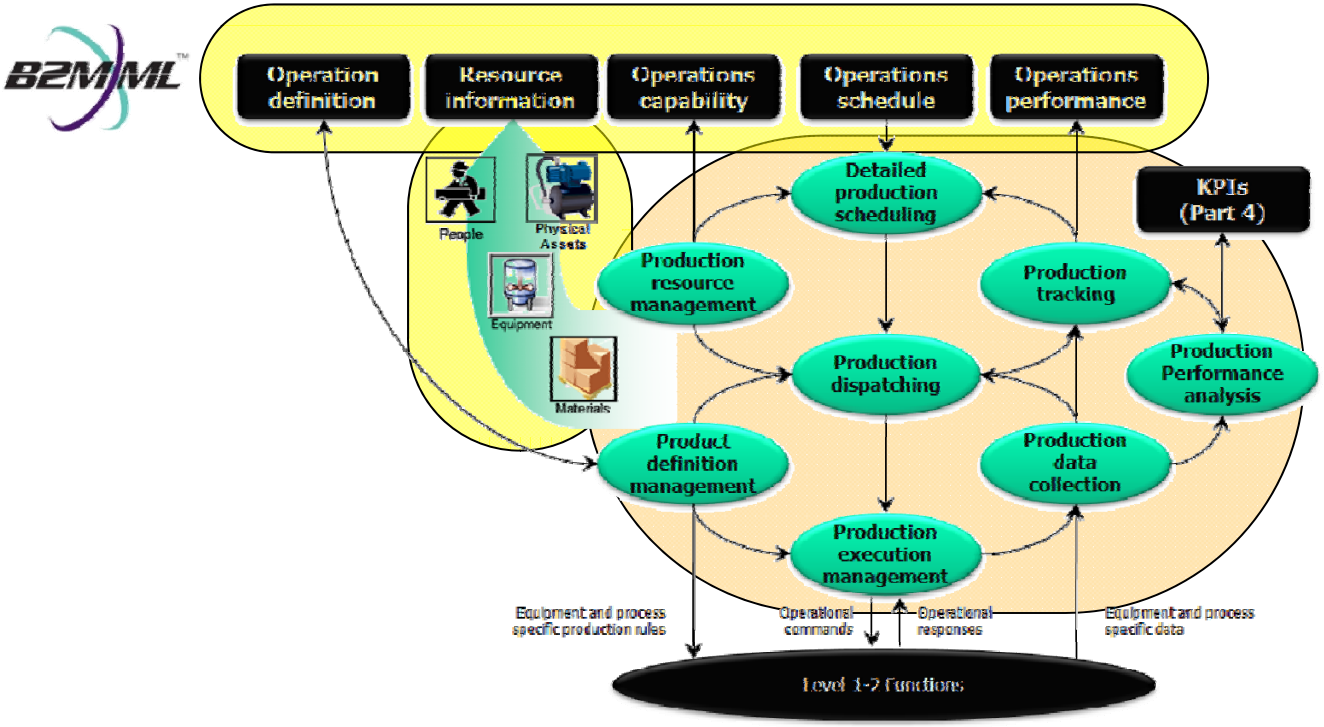
ISA 95 Formal Models

- Interfaces to business systems (ERP, MDM, PLM) through XML and WBF B2MML Standard (www.wbf.org)
- Standard model for MOM tasks and activities



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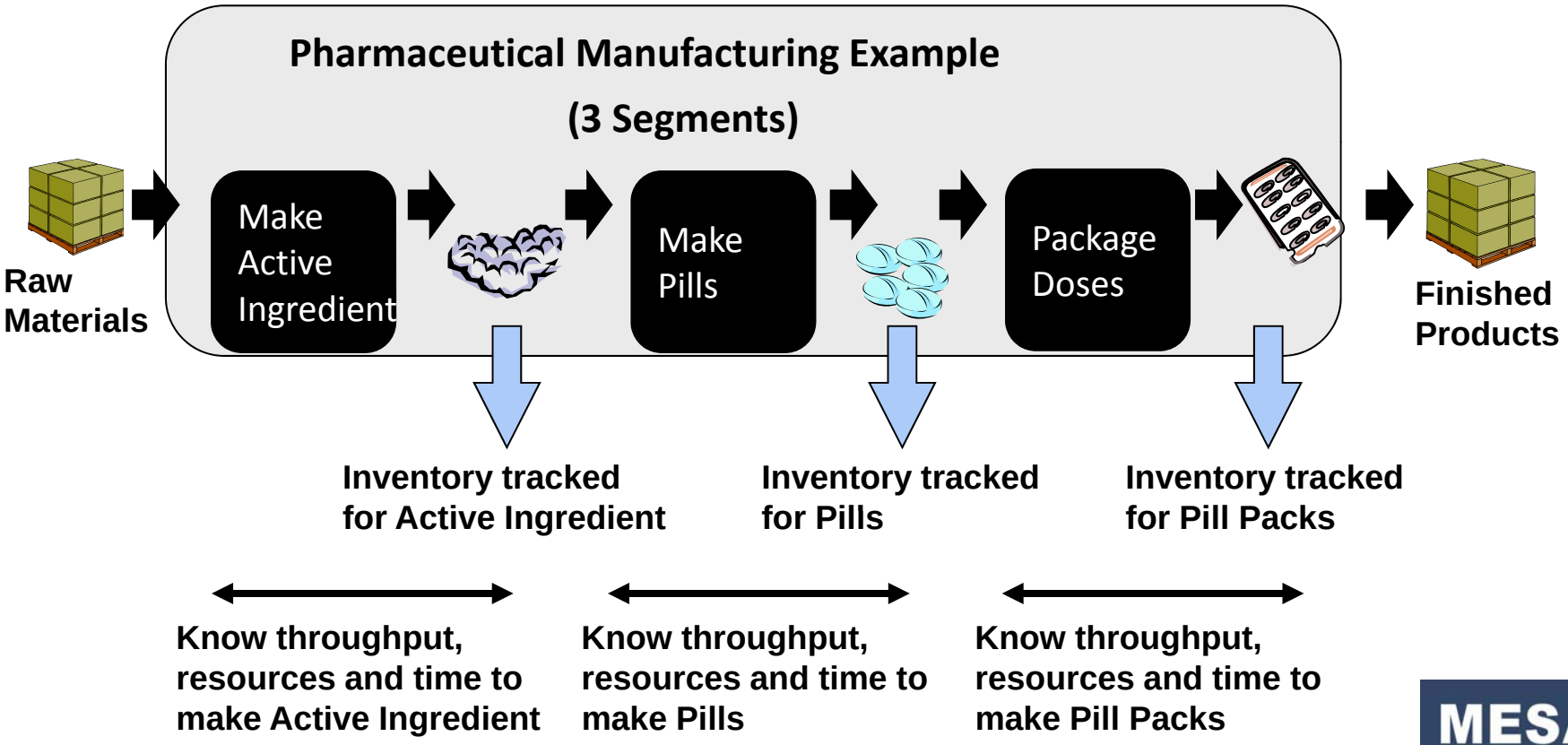
Process Segments

- Defines the **Business View** of production



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Integration Models

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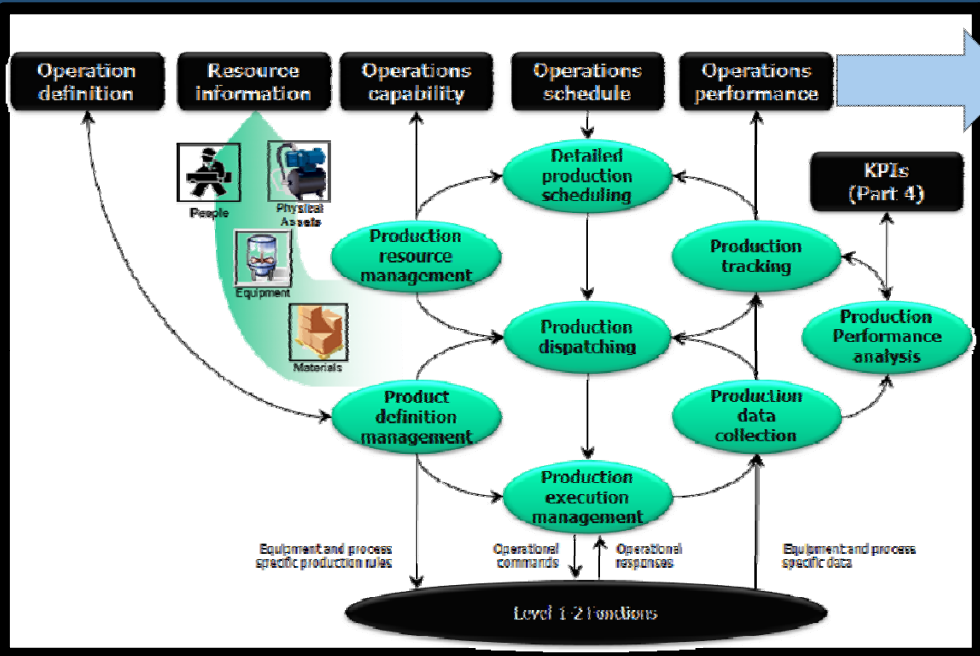
Enterprise Integration – ISA 95 & B2MML

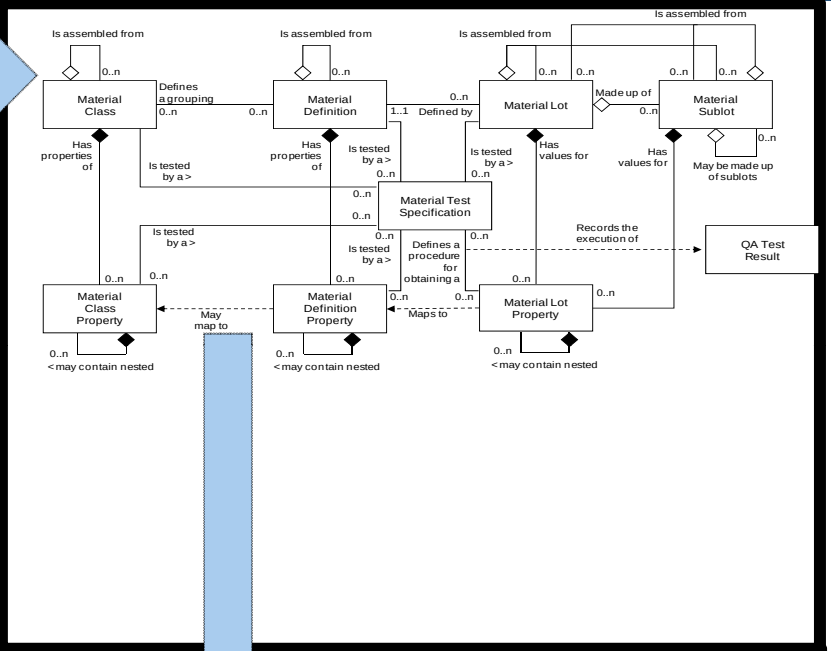
- Integration of business systems to shop floor systems is an important final phase in an ERP implementation
  - Companies are discovering that the true value in a logistics system only comes when it is connected to real world shop floor information.
- The ISA 95 and IEC 62264 standards define the **standard terminology** for business to manufacturing integration
- The WBF B2MML (Business to Manufacturing Markup Language) defines **an implementation** emerging as the preferred integration method

How Does ISA 95 & B2MML Help?

- ISA 95 Part 1, Part 2, and Part 5
  - Provides a clear description of exchanged information
    - Does not use vendor specific terminology
  - Each piece of exchanged information has an unambiguous meaning
    - Uses a “Property” model to describe company specific exchange information
  - Allows separation of business processes from manufacturing processes
    - Allows changes in production processes without requiring unnecessary changes to scheduling and logistics processes
- B2MML
  - Defines an implementation of the ISA models in an XML format
  - Defines a standard language for representing exchanged information

ISA 95 & B2MML Data Models

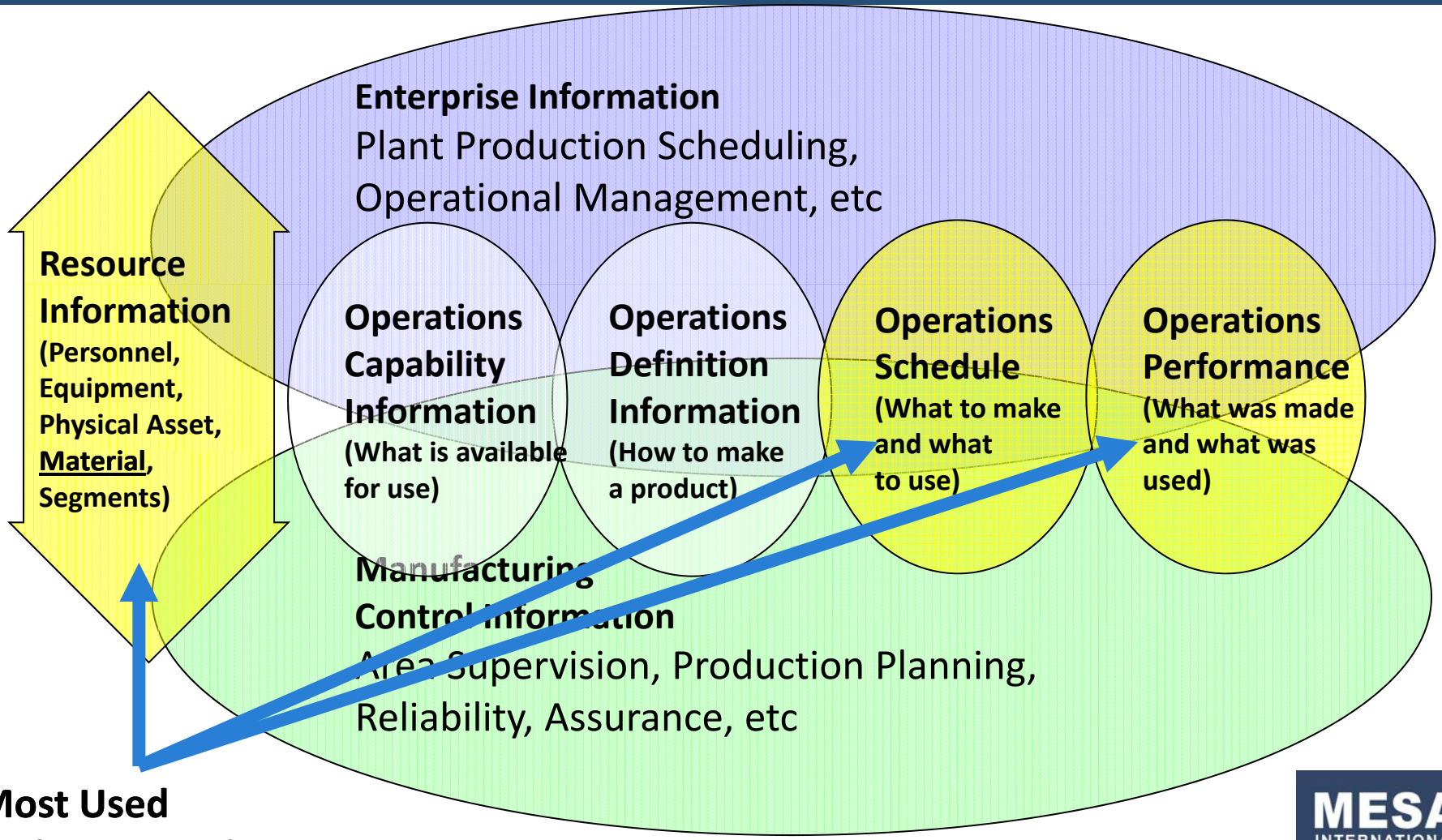





```
<Material
   <MaterialLot>
      <ID> W89 </ID>
      <Description> A lot of material </Description>
      <MaterialDefinitionID "WXE908" />
         <Location> Tank 1  </Location>
      <Quantity UnitOfMeasure = "KL" > 4500
      </Quantity>
      <MaterialLotProperty>
         <ID> dateTimeProduction </ID>
         <Value> 2001-01-06T00:14:23+11:30 </Value>
      </MaterialLotProperty>
      <MaterialLotProperty>
         <ID> Quality Status </ID>
         <Value> Good </Value>
      </MaterialLotProperty>
   </MaterialLot>
</Material>
```

Attribute Name	Description	Production Examples	Maintenance Examples	Quality Examples	Inventory Examples
ID	A unique identification of a specific *material class*, within the scope of the information exchanged (*production capability*, *production schedule*, *production performance*, ...)	Polymer sheet stock 1001A	200 cP Oil (SAE 90)	RH5510	20 mil Wrap
Description	Additional information about the *material class*.	Solid polymer resin	Very High Viscosity Lubricating Oil	Oxidizing Agent	Wrap used to wrap pallets
Assembly Type	Optional: Defines the type of the assembly.	Physical	Physical	Logical	Physical
Assembly Relationship	Optional: Defines the type of the relationships .	Permanent	Transient	Permanent	Transient

Exchanged Level 3-4 Information



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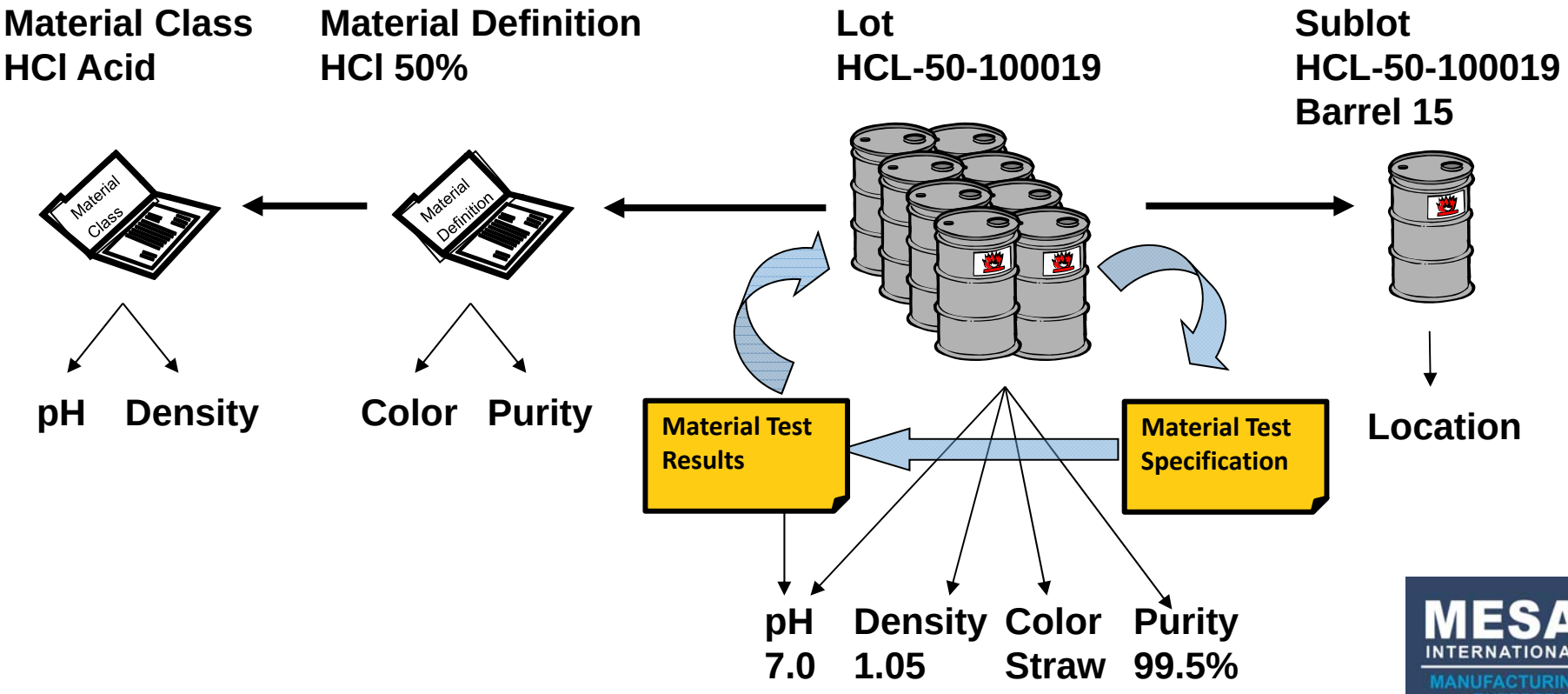
Material Information

- What is shared
- Material Master & Material Inventory information

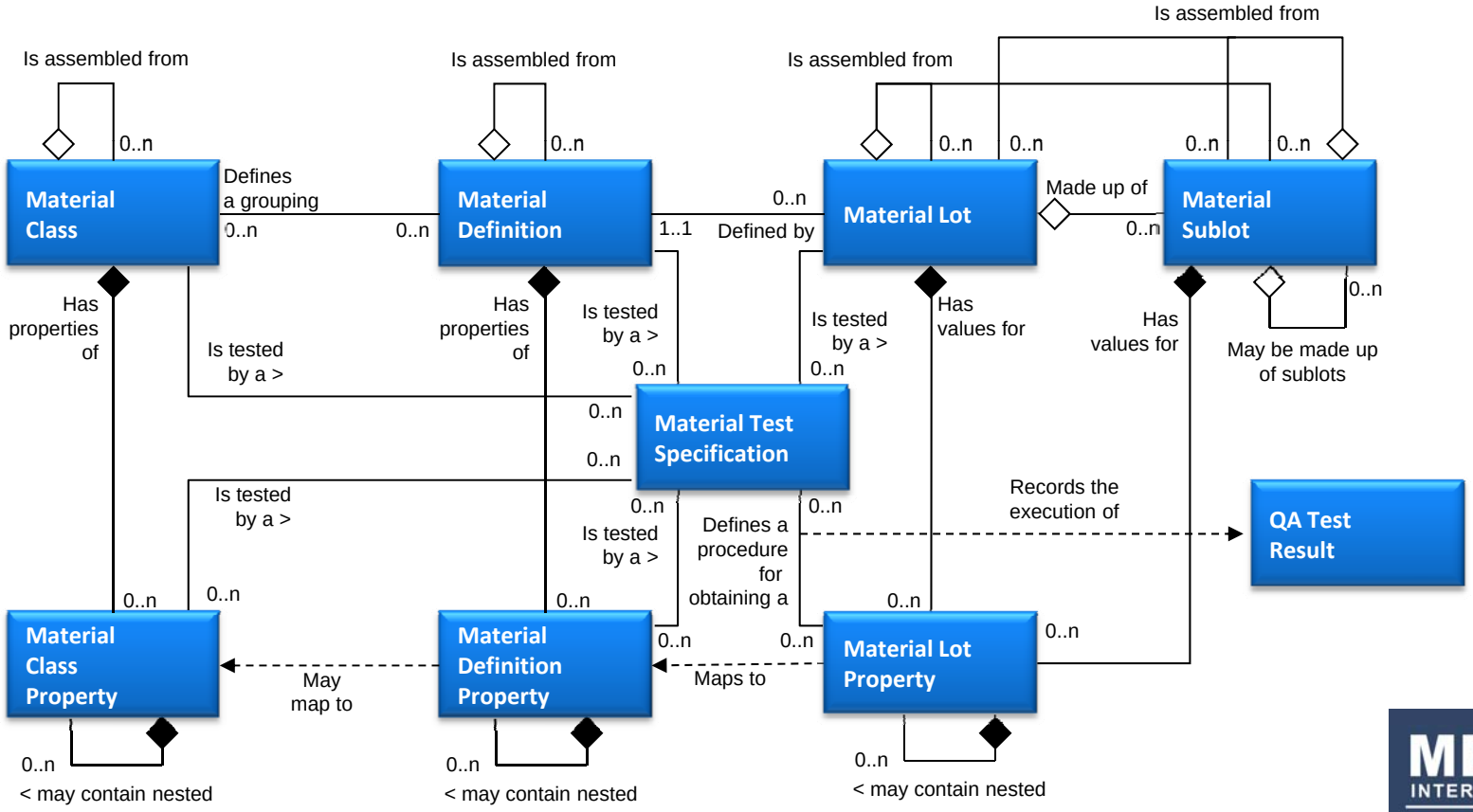


Material Information

- Material Master
  - Represented in “Material Definition” & “Material Class”
  - Usually sent from ERP (SAP) to MOM systems
    - Triggered by changes to material masters or changes sent on a regular basis (every shift, once a day, …)
  - Widely used in MOM activities to identify materials
- Material Inventory
  - Represented in “Material Lot” & “Material Sublot”
  - Contains quantity, location, status information and company specific properties
    - Example: pH, octane, “Use by date”, QA status, …

Material Information – ISA 95 Model

- Exchange information about properties of material lots, sublots, definitions, and classes



Material Information – B2MML Document

```
<Material>
    <MaterialLot>
        <ID> W89 </ID>
        <Description> A lot of material </Description>
        <MaterialDefinitionID “WXE908” />
            <Location> Tank 1  </Location>
        <Quantity UnitOfMeasure = "KL" > 4500
        </Quantity>
        <MaterialLotProperty>
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            <Value> 2001-01-06T00:14:23+11:30 </Value>
        </MaterialLotProperty>
        <MaterialLotProperty>
            <ID> Quality Status </ID>
            <Value> Good </Value>
        </MaterialLotProperty>
    </MaterialLot>
</Material>
```
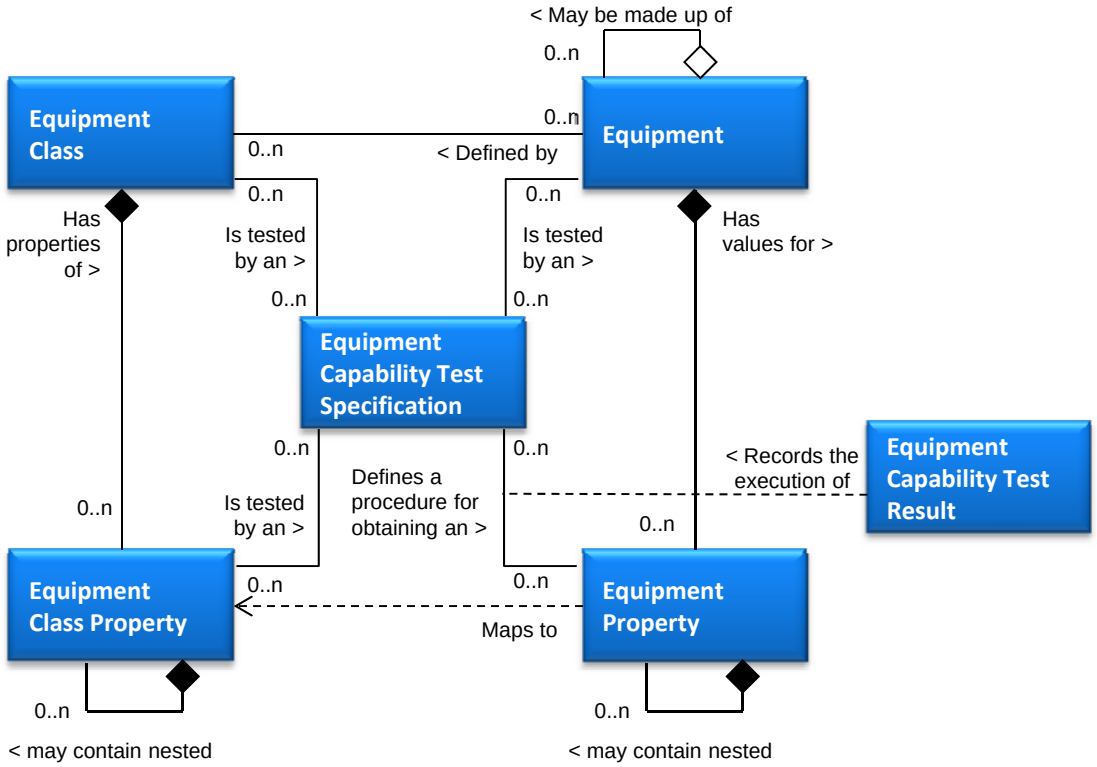
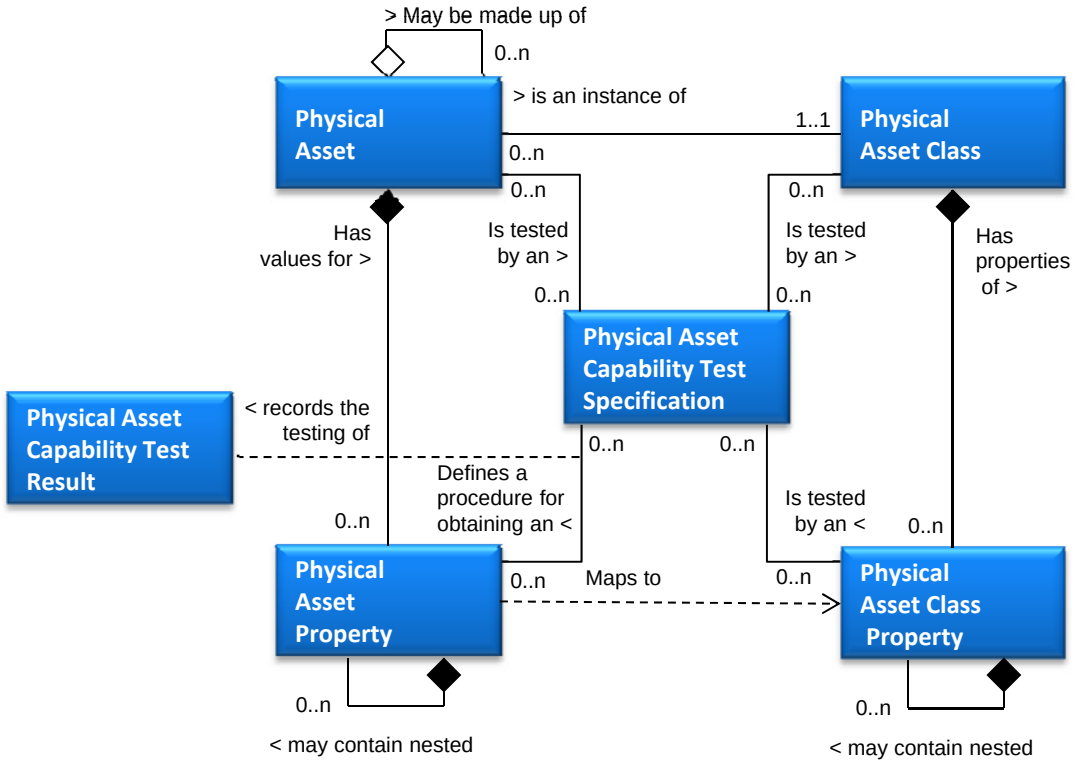

Role Based Equipment Information

- Exchange information about properties of specific equipment and equipment classes
- The specific properties are defined by the end user
  - Example: Validated for specific equipment, in-use, sterile, benchmark capacity, heat transfer efficiency, …



Physical Asset Information

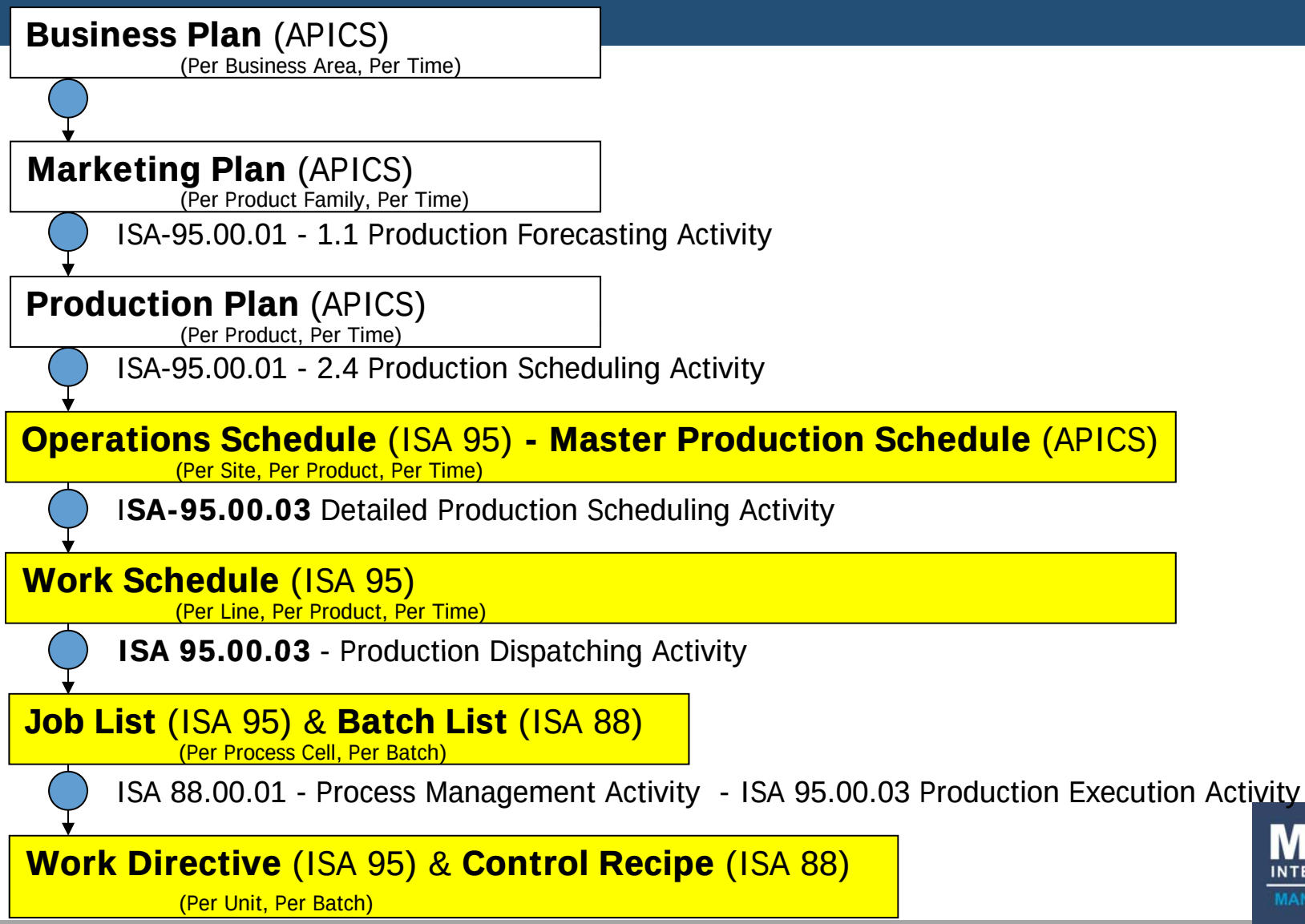
- Exchange information about properties of specific physical assets and physical asset classes
- The specific properties are defined by the end user
  - Example: In maintenance, last used date, stock power, …



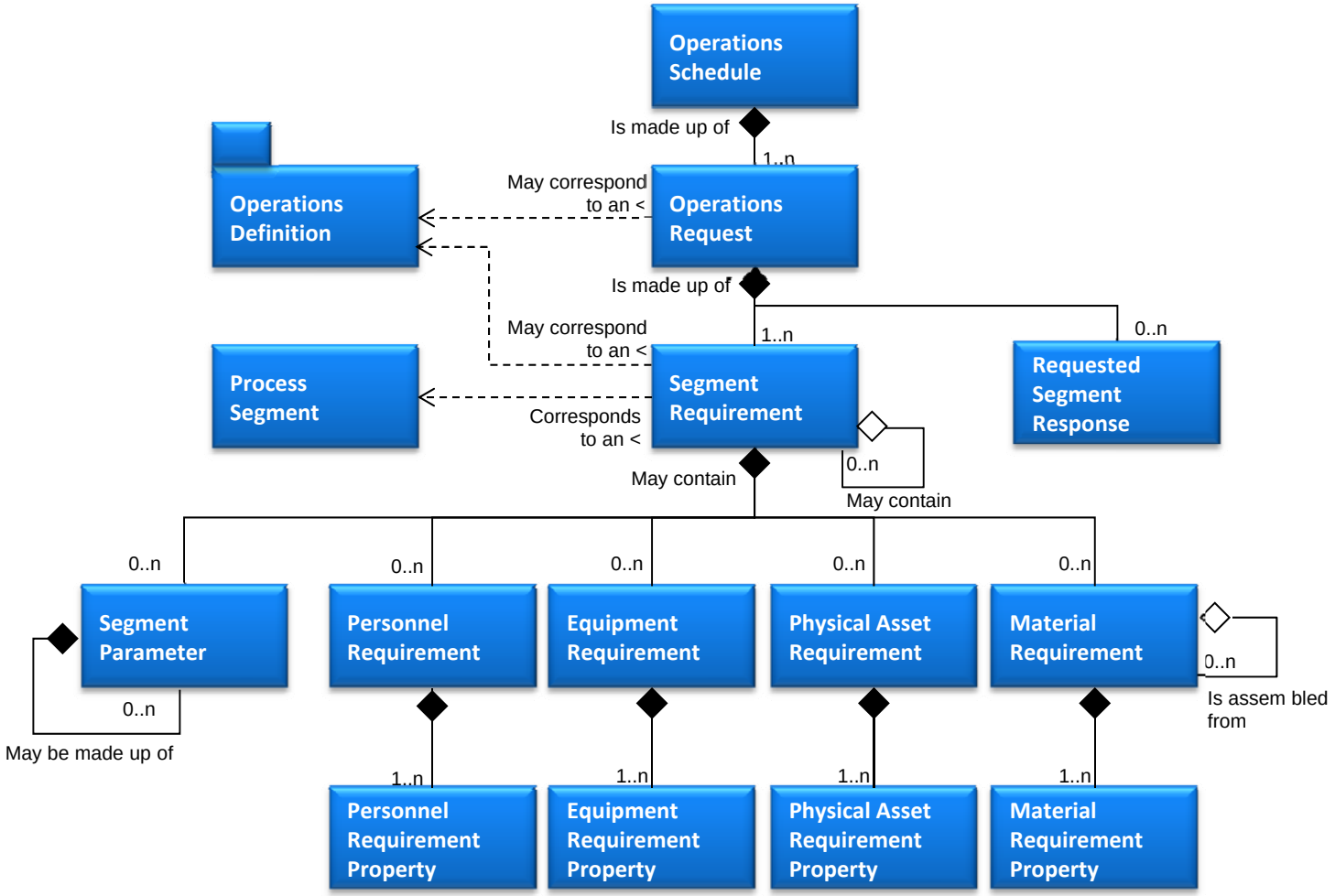
Operations Schedule

- What actions to perform
  - Materials to make
  - Priority and/or dates
  - What materials to use
  - What equipment to use
  - What personnel to use
  - Production parameters (e.g. Color, Options,…)
- Per Segment (step in production)
- Per location (Site, Area, …)
- Per week, day, shift, order, …

Scheduling Hierarchy



Operations Schedule



Operations Performance

- What was done
  - What material was produced & how much
  - What material was consumed or used & how much
  - What equipment was used & how long
  - What personnel were used & how long
- Per Segment (step in production)
- Per location (Site, Area, …)
- Per week, day, shift, order, …

It Takes More Than Just Schemas

- The B2MML standard defines the structure of integration data
- But, it does not define the detailed definition of the source and target exchanged data
- B2MML provides a template or format, much as a blank check, but does not specify the source or destination of the data in the application name space
- Multiple methods exist for data mapping

An XML Example
Production Schedule

```
<?xml version="1.0" encoding="iso-8859-1" ?>
<OperationsSchedule>
  <ID>00000008872</ID>
  <OperationsRequest>
    <ID>0010</ID>
    <Description>Use Case</Description>
    <OperationsType>Production</OperationsType>
    <OperationsDefinitionID>6005-3</OperationsDefinitionID.
    <SegmentRequirement>
      <ID>0011</ID>
      <LatestEndTime>2011-10-11T19:31:34</LatestEndTime>
      <EquipmentRequirement>
        <EquipmentID>MT60</EquipmentID>
      </EquipmentRequirement>
      <MaterialRequirement>
        <MaterialUse>Produced</MaterialUse>
        <Quantity>400</Quantity>
      </MaterialRequirement>
    </SegmentRequirement>
  </OperationsRequest>
</OperationsSchedule>
```

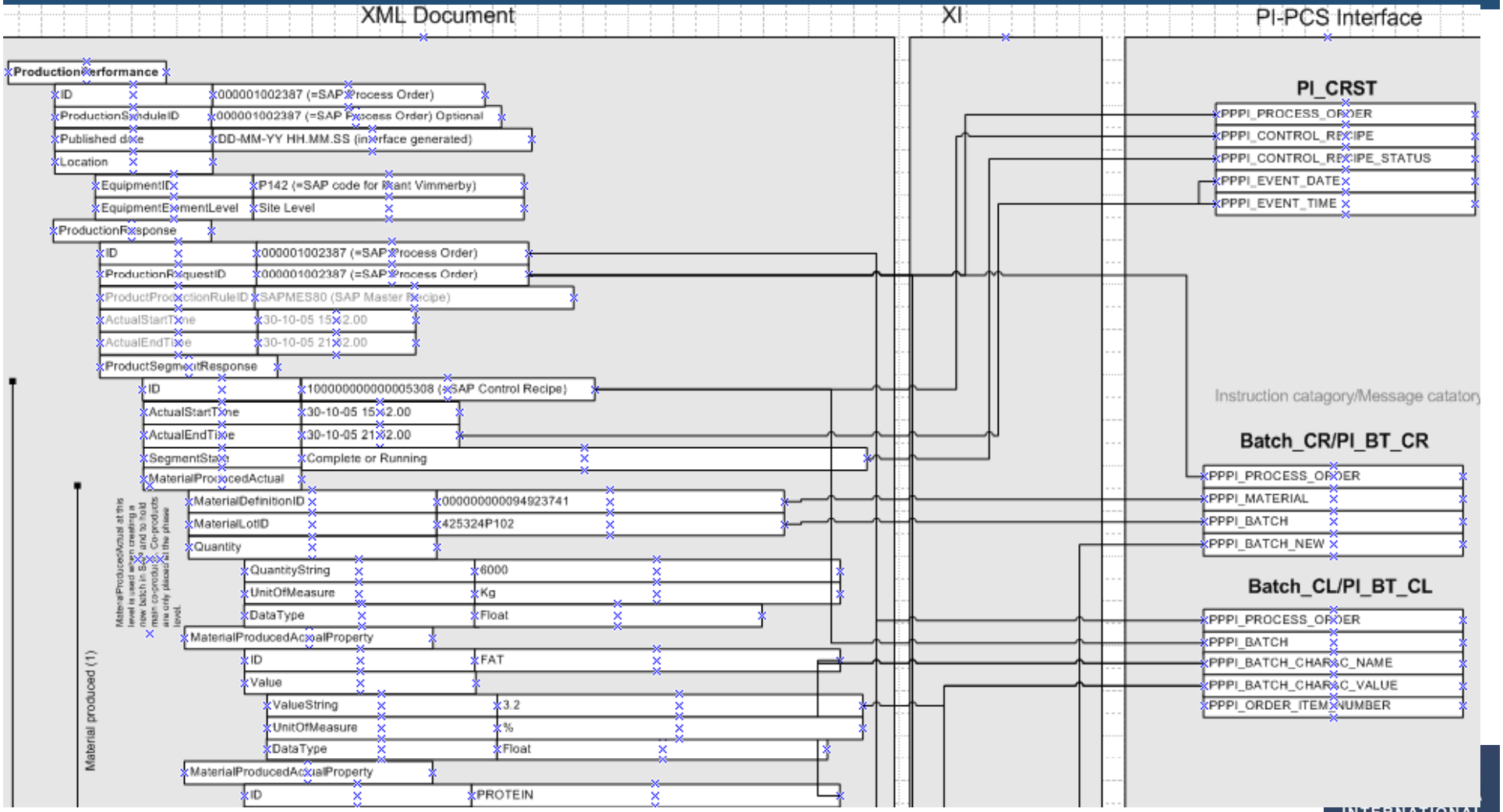
Operation Schedule

Operation Request

Segment Requirement

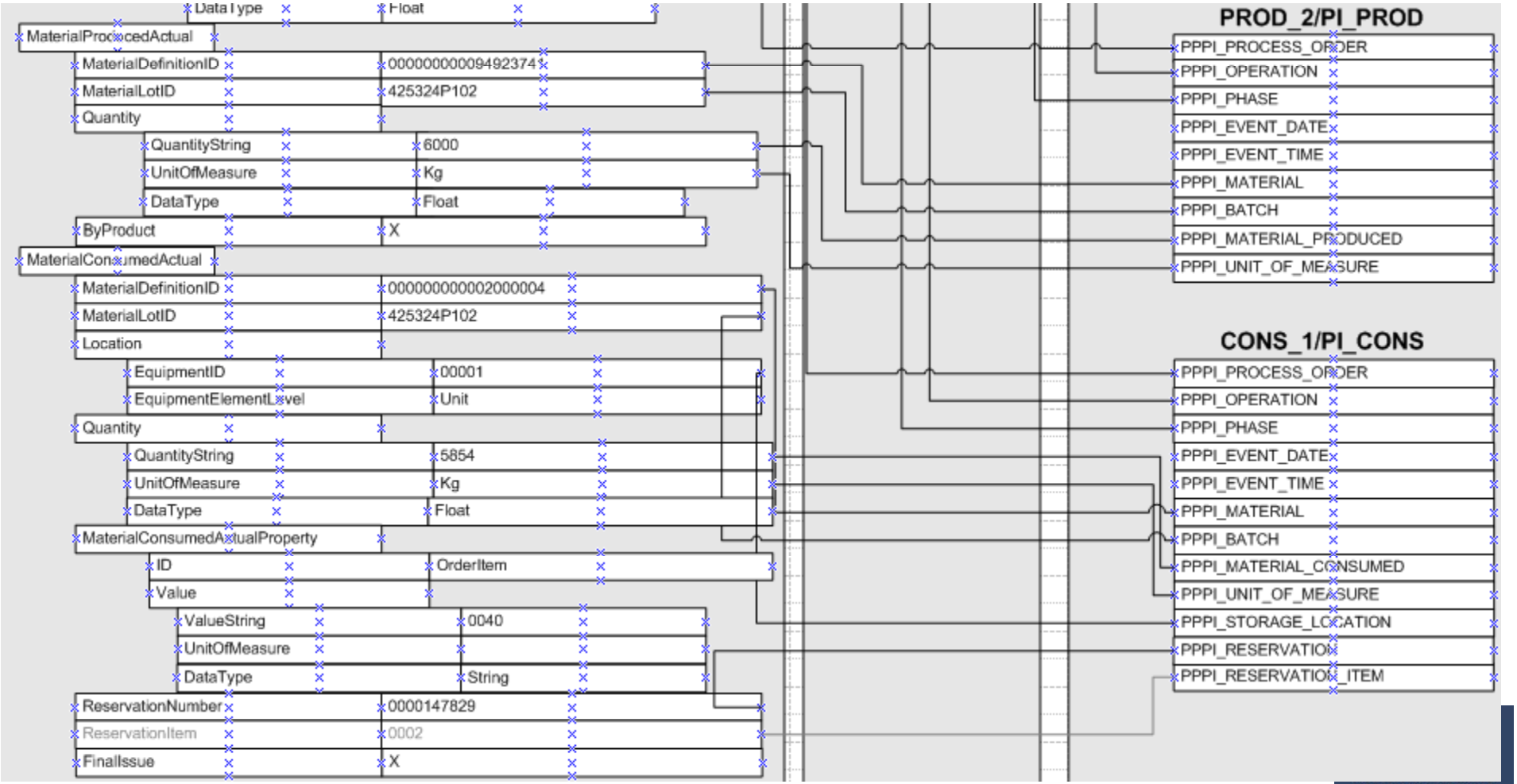
Material Produced

Production Performance Mapped to SAP PI-PCS Interface



ProductionPerformance_Vimmerby_2002.vsd

Material Produced, Material Consumed to SAP



Data Mapping
B2MML Mapping Spreadsheets

- Document mapping in format suitable for implementation
- Available on the WBF web site

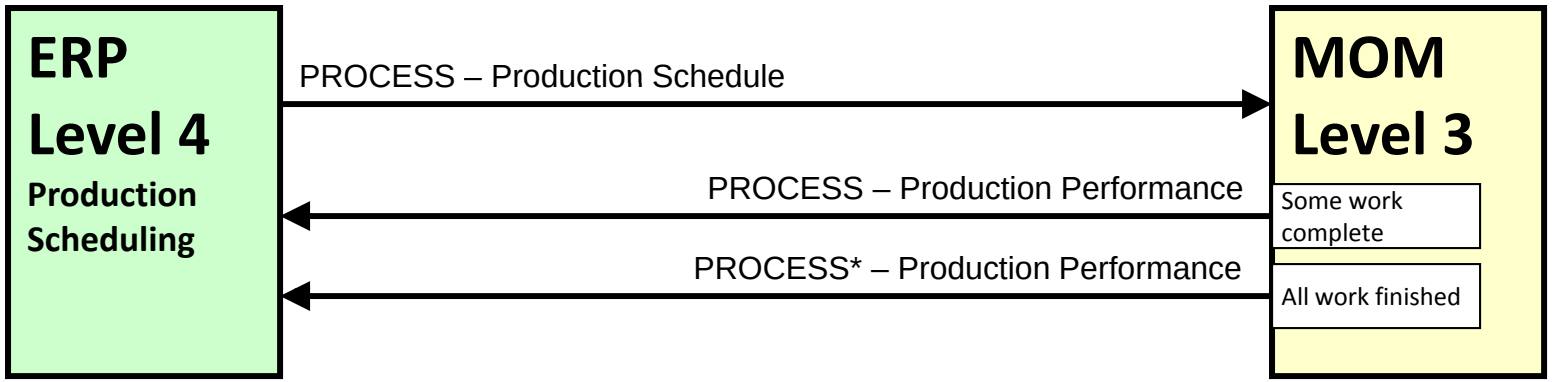
	A	C	D	E	F	G	
1			SyncProductionSchedule		From Zeus	To Apollo	
2					Specification ID	Specification ID	
3	Mappe	Full Path	Tree View - Unhide Column B for Sort Column	Note	Xpath	Flat File - Field	
71	Mapped	/SyncProductionSc	|--PersonnelRequirement		-		
86	Mapped	/SyncProductionSc	|--PersonnelRequirementProperty		-		
106	Mapped	/SyncProductionSc	|--EquipmentRequirement		-		
121	Mapped	/SyncProductionSc	|--EquipmentRequirementProperty		-		
141	Mapped	/SyncProductionSc	|--MaterialRequirement		One Material Requirement for the Produced Material		
143	Mapped	/SyncProductionSc	|--MaterialDefinitionID		../ProductionOrderMaterial/Identification/ID	Produced Item Code	S
151	Mapped	/SyncProductionSc	|--MaterialUse	Fixed text	"Produced"		
153	Mapped	/SyncProductionSc	|--QuantityString		../ProductionOrderMaterial/PlannedQuantity	Produced Quantity Code	S
155	Mapped	/SyncProductionSc	|--DataType	Fixed text	""		
156	Mapped	/SyncProductionSc	|--UnitOfMeasure		../ProductionOrderMaterial/PlannedQuantity@unitC	Produced Quantity UOM	S
159	Mapped	/SyncProductionSc	|--MaterialRequirementProperty		-		
160	Mapped	/SyncProductionSc	|--ID	Fixed text	"Expiration Date"		
163	Mapped	/SyncProductionSc	|--ValueString		../ProductionOrderMaterial/ItemReference/Specific	Planned Epiration Date	
165	Mapped	/SyncProductionSc	|--DataType	Fixed text	"dateTime"		
166	Mapped	/SyncProductionSc	|--UnitOfMeasure	Fixed text	""		
179	Mapped	/SyncProductionSc	|--MaterialRequirementProperty		-		
180	Mapped	/SyncProductionSc	|--ID	Fixed text	"Potency"		
183	Mapped	/SyncProductionSc	|--ValueString		../ProductionOrderMaterial/ItemReference/Specific	Planned Potency	
185	Mapped	/SyncProductionSc	|--DataType	Fixed text	""		
186	Mapped	/SyncProductionSc	|--UnitOfMeasure		../ProductionOrderMaterial/ItemReference/SpecificationGroup/Specification[Nam		
199	Mapped	/SyncProductionSc	|--MaterialRequirement		One MaterialRequirement for each Consum	One Line Per Consumed Mate	
201							

Document History | Sync | Process | Get | Show

ISA 95 Part 5 - Transactions

Verb	Description
GET	Request to a receiver for information on one or more objects. The response is a **SHOW** message. The receiver returns a SHOW message containing all the specified attributes and all the specified contained elements of the specified nouns. If no attribute or contained element is specified in the noun area, then all attributes and/or contained elements shall be returned. When wildcards are applied to the noun and property IDs, it shall be possible to further filter the information to be returned by specifying a value for one or more attributes of the noun. Only objects whose attributes match the specified value (out of the list of objects matching the wildcards applied to noun and property IDs) shall be returned.
PROCESS	Request to a receiver to process new information. The response is an **ACKNOWLEDGE** message. A new noun is added.
CANCEL	Request to a receiver to remove information. The specified noun is canceled.
CHANGE	Request to a receiver to change information. The response is a **RESPOND** message. The specified attributes and contained elements of the noun are changed.
SYNC ADD	Request from the owner of the object to add information.
SYNC CHANGE	Request from the owner of the object to change information.
SYNC DELETE	Request from the owner of the object to delete information.
CONFIRM	Confirmation response to a request.

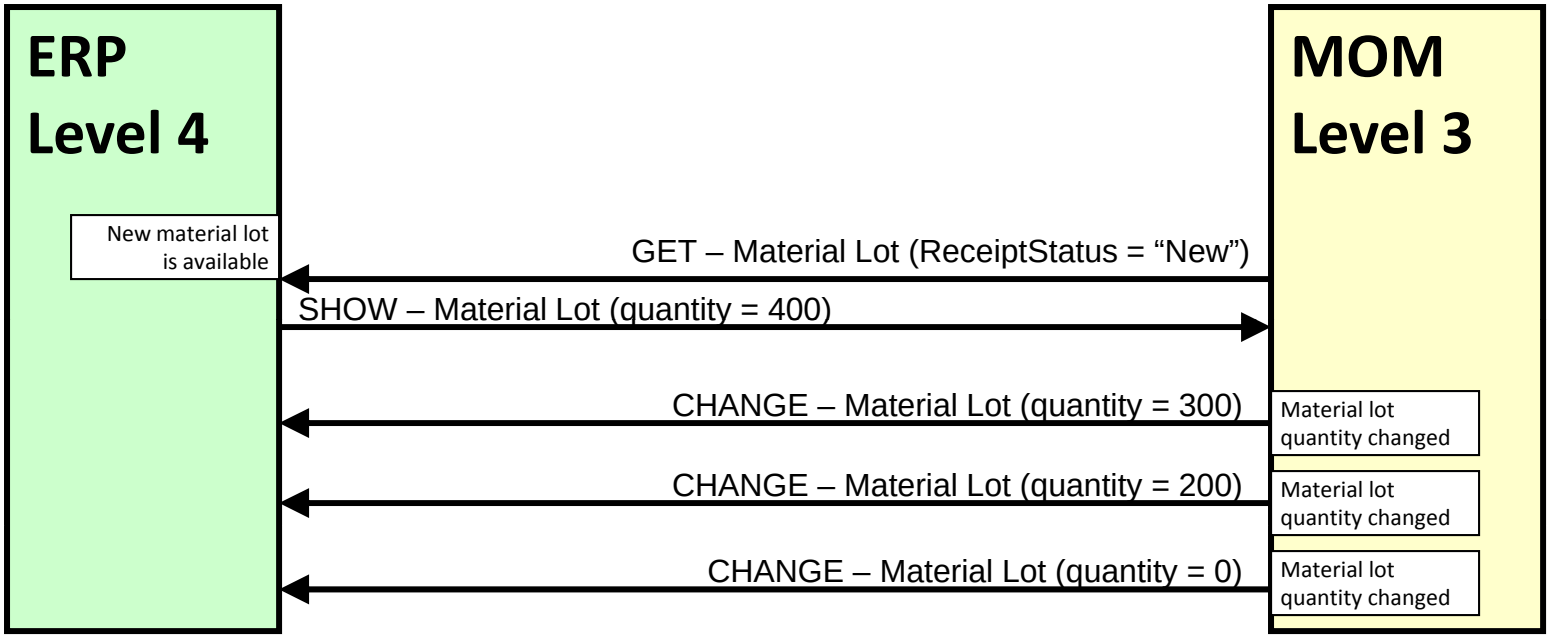
Push Transactions in Business Process



Scenario assumptions:
1. ERP send production schedule to MOM for processing
2. MOM (Manufacturing Operations Management) sends production performance to ERP for processing

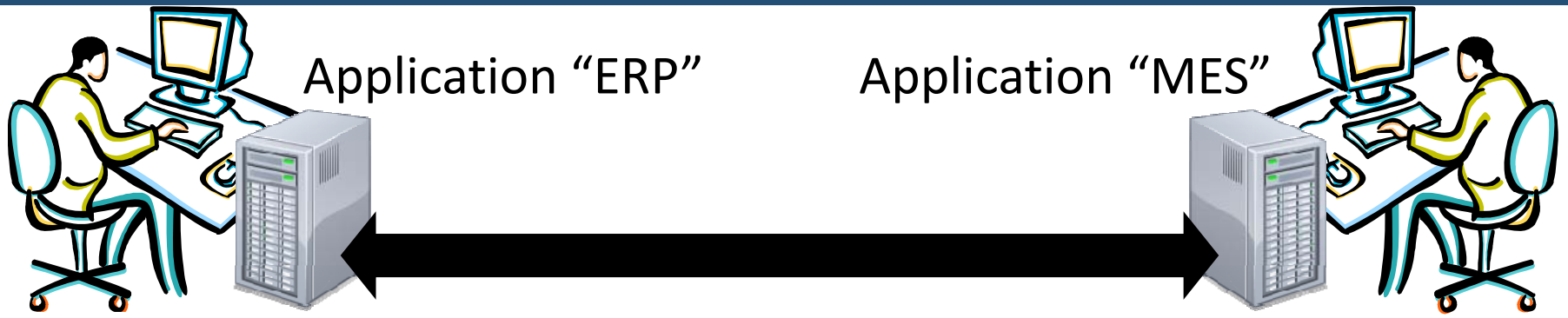
* Message contains a FINAL flag to indicate that the message is the final production performance for the associated production schedule.

Push and Pull
Manage Material Lot Quantity



Scenario assumptions:
1. MOM requests material lot information from ERP
2. ERP sends information on new material lots (lots with no changes)
3. MOM pushes quantity changes in material lot to ERP

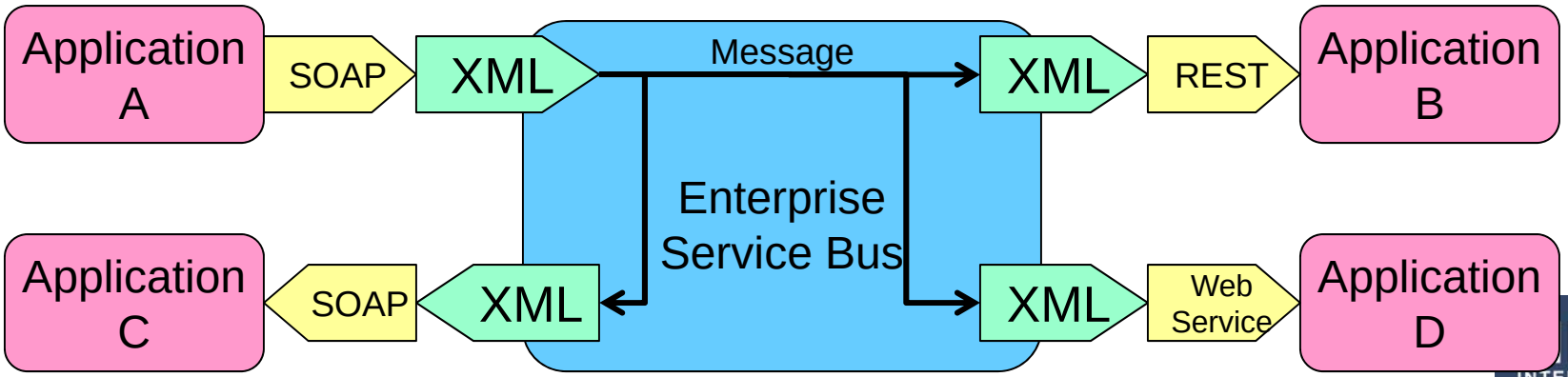
Applications Need To “Talk”



- Integration is application-to-application data exchange
- Across firewalls, through APIs, web services or flat files, across a wire, often in different languages, data formats, at different time cycles, on different systems, of different ages, supported by different departments, …
- ISA 95 and B2MML only provide part of the solution

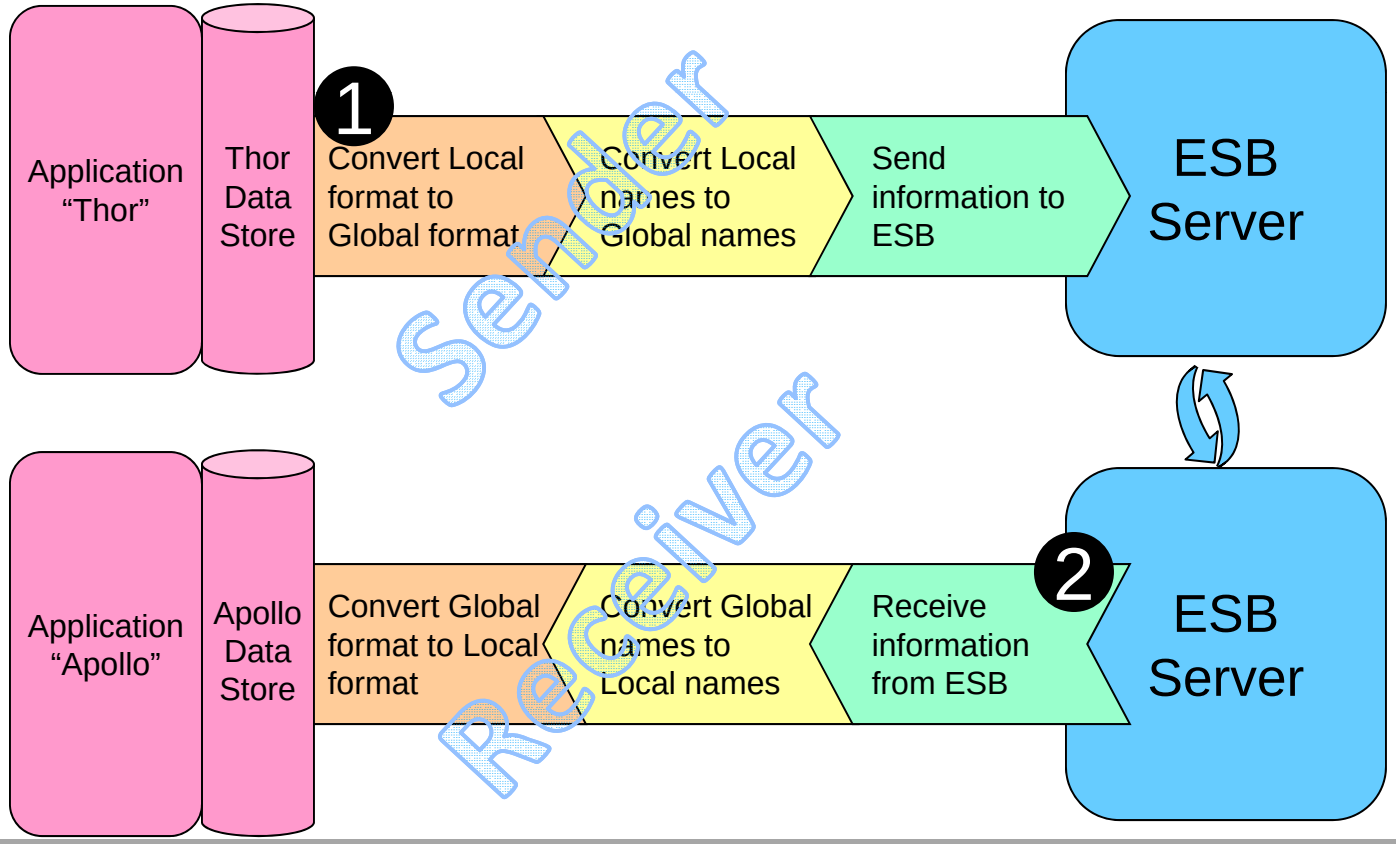
Integration - The Current Situation

- **Message based protocols** have become the standard model for enterprise integration
- **Enterprise Service Buses** (ESB) have become the standard model for exchanging integration messages
- **XML** has become the standard model for data representation within messages
- **SOAP** and **REST** have become the standard interfaces to ESBs
- **Web services** have become the standard for SOAP implementations



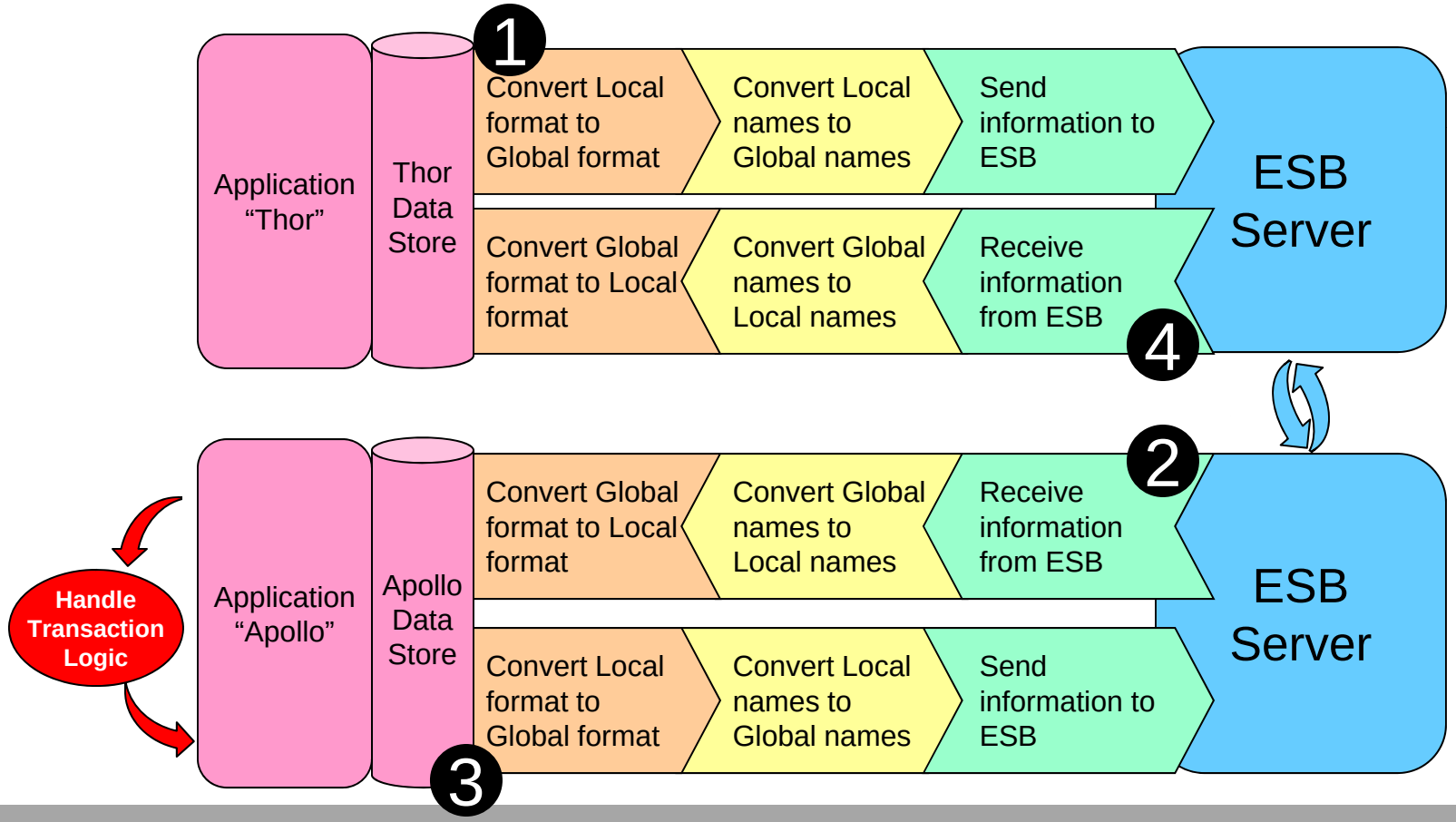
Integration : The Hidden Complexity

- Every integration project needs the following elements
- Some communication is one way ❶ → ❷



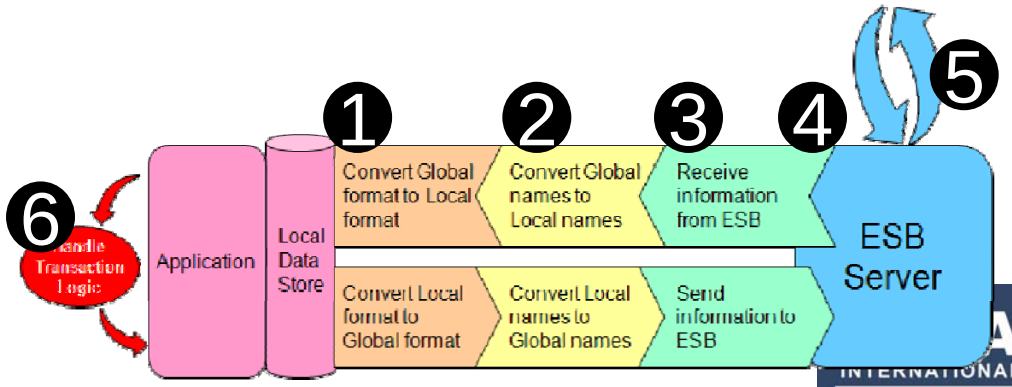
Integration – Two Way Communication

- Multiple translations, copies, services, …
- Some communication is two-way ❶ → ❷ → ❸ → ❹



Many Layers for Integration

- Convert Formats (**B2MML**)
  - From local to project selected common (canonical) formats
  - From canonical to local format
- Convert Names (Planned **ISA 95 TR.02**)
  - From local names to common names (tags, status, …)
  - From common names to local names
- Send/Receive messages (Planned **ISA 95 TR.03**)
  - Publish-Subscribe methods
  - Query-Response methods
- Link to ESB
  - API, Web Service, …
- Exchange Messages across ESB
  - IP, Internet, Ethernet, WAN, VPN, ,,,
- Transaction Logic
  - Rules for handling of messages



B2MML Implementations

- Multiple publicly discussed implementations:
  - Nestle, Arla Food, Cerveceria Polar, P&G
  - All have SAP as at least one of the ERP systems connected
- Technically
  - The solutions are not much different from each other
  - All using Business Connector combined with different access to R/3: PI-PCS, IDOCS, BAPI calls, XI.
- All experienced significant improvements in integration efforts
  - For connection to different ERP systems
  - For connection to different MES and control systems

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ISA95 Part 3

Models of Manufacturing Operations

The new model for MES

MESA*KNOWS*

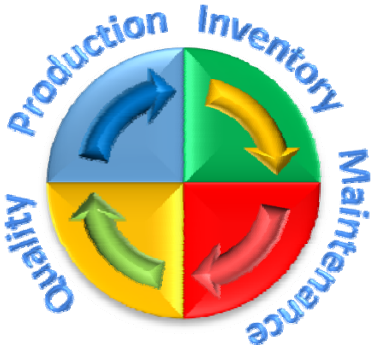
SUSTAINABILITY & ECO-EFFICIENCY - LEAN - METRICS & PERFORMANCE MANAGEMENT
INFORMATION INTEGRATION - SAFETY - ASSET PERFORMANCE MANAGEMENT - B2MML
QUALITY & COMPLIANCE - PRODUCT LIFECYCLE MANAGEMENT - AUTOMATION

Do you know MESA?

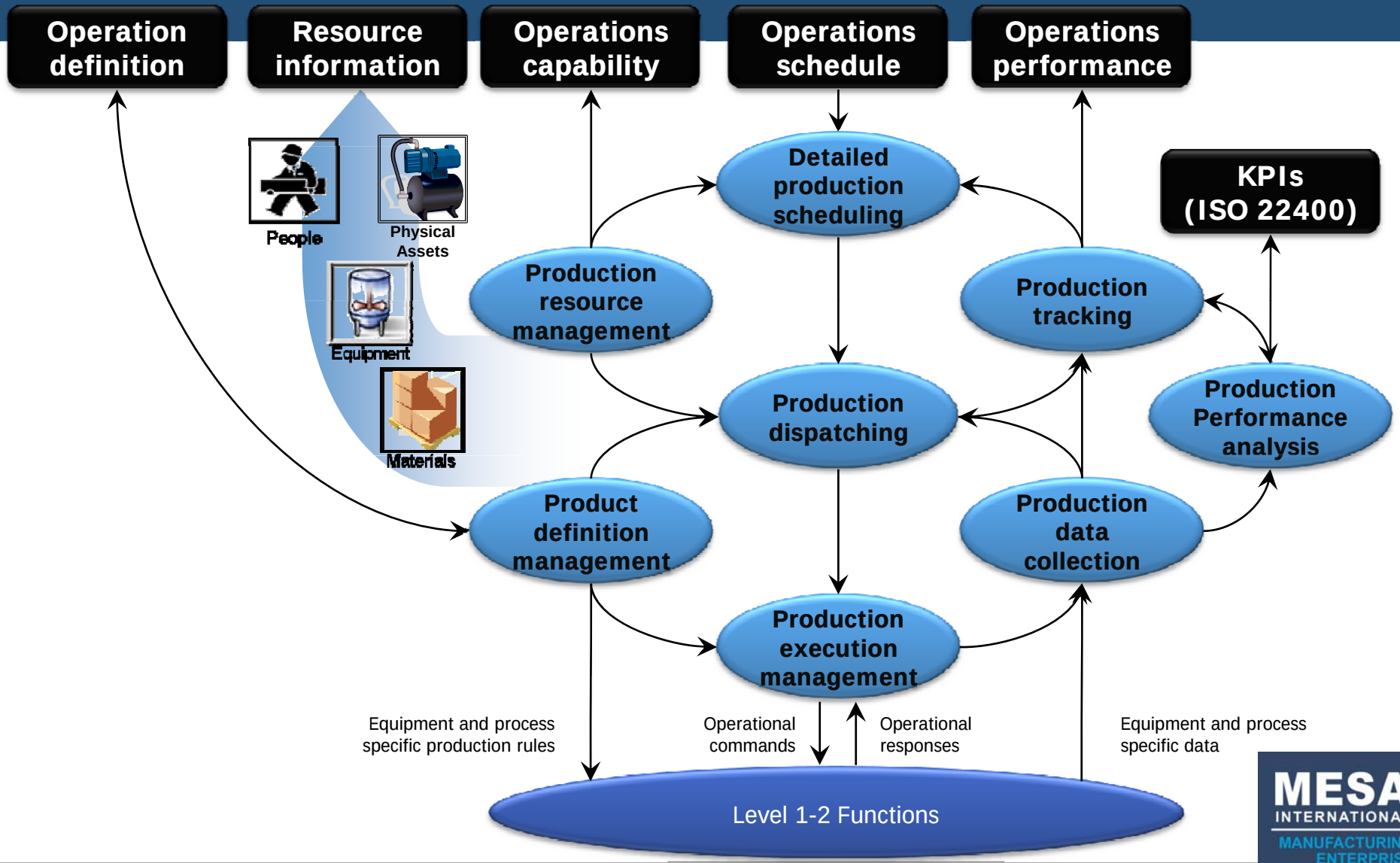
ISA 95
4 Categories of MOM Activities

- Production Operations Management
  - Activities that coordinate, direct, manage & track the functions that use raw materials, energy, equipment, personnel and information to produce products
- Quality Operations Management
  - Activities which coordinate, direct & track the functions that measure and report on quality
- Inventory Operations Management
  - Activities which coordinate, direct & track the functions that manage and track the inventory of product and/or material and their movements
- Maintenance Operations Management
  - Activities which coordinate, direct and track the functions that maintain the equipment, tools and related assets to ensure their availability for manufacturing

- Models have also been applied to:
  - Shipping, Receiving, Transportation, …



Models of Production Activities & Data



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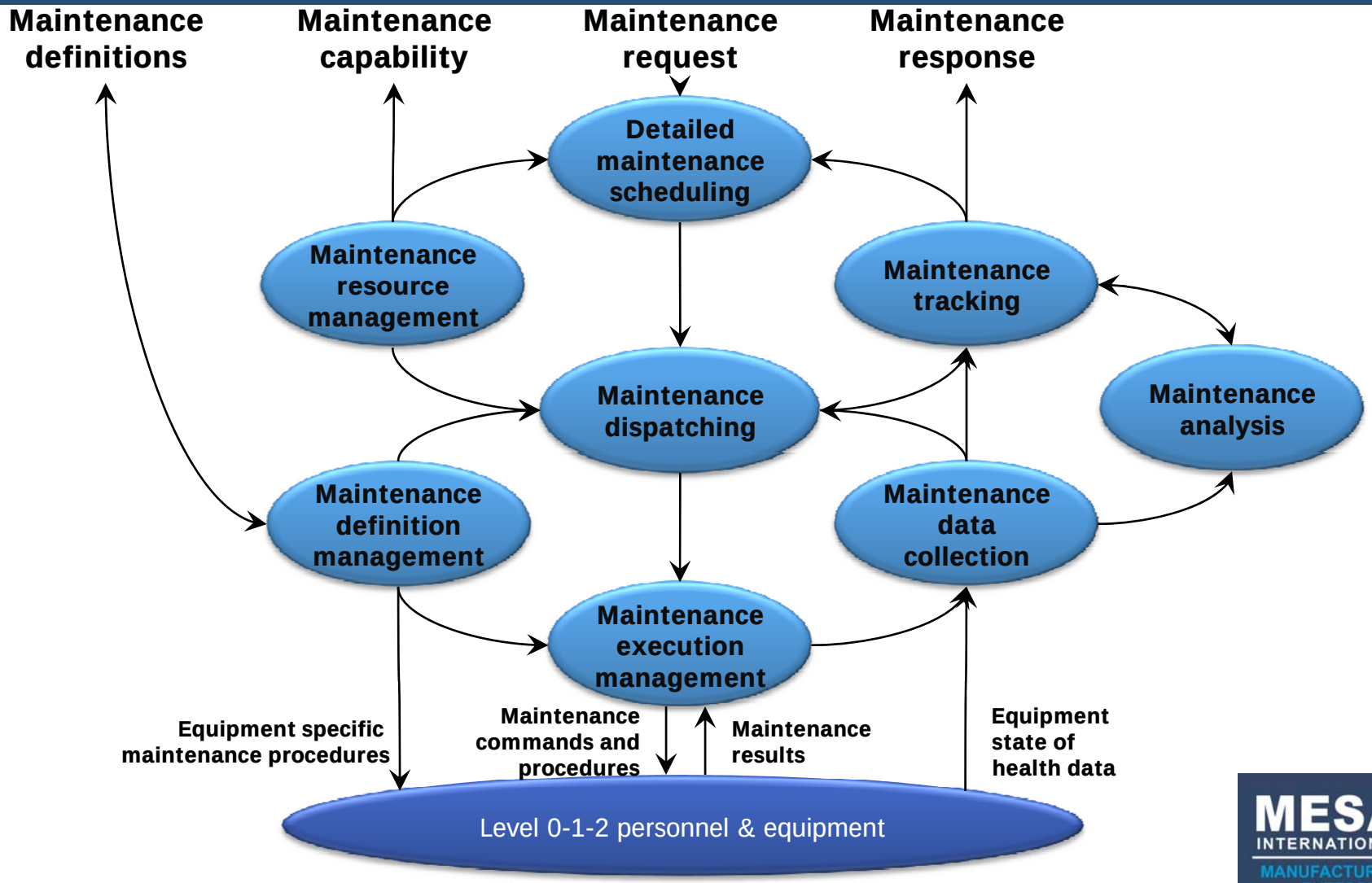
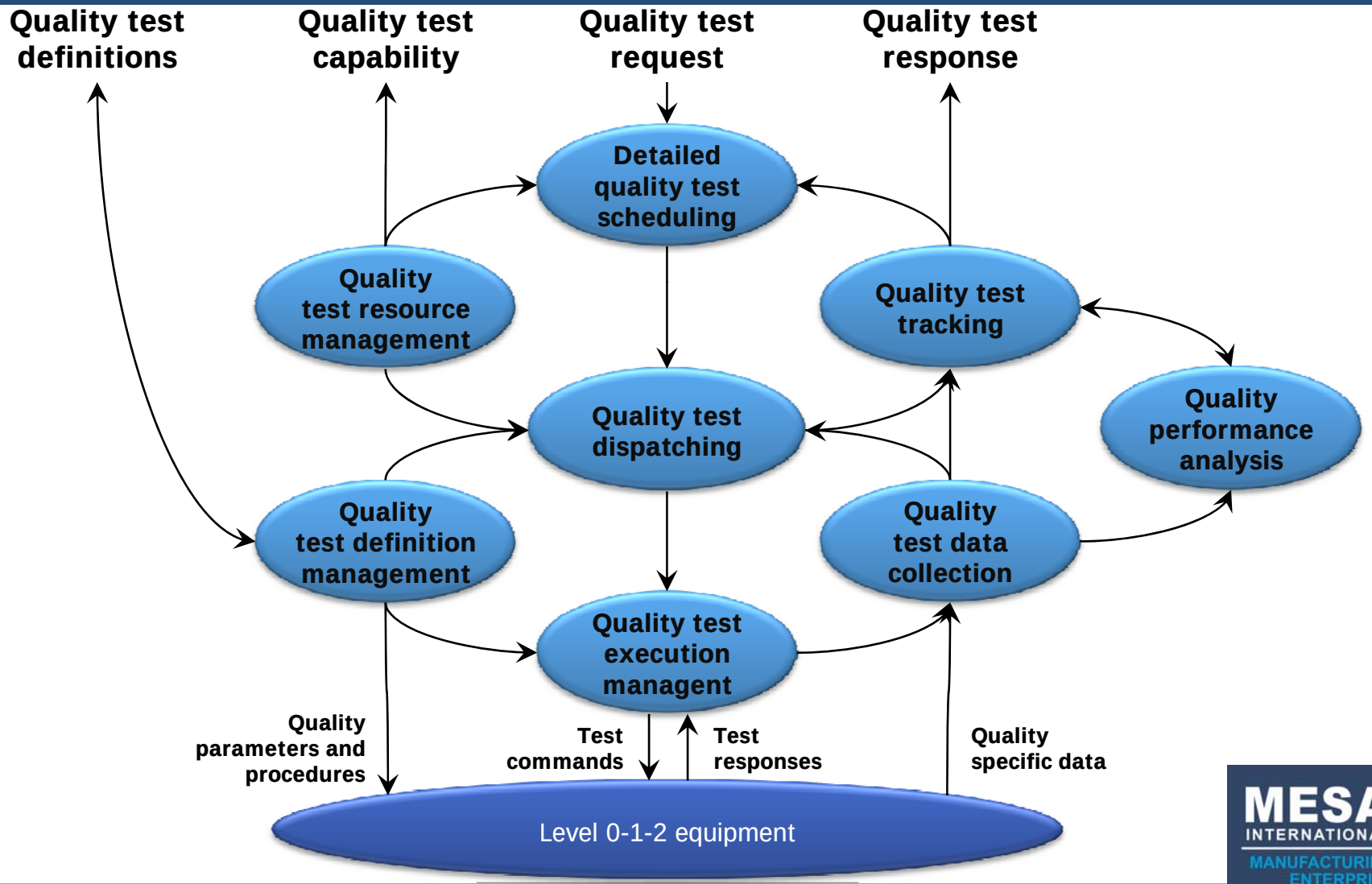
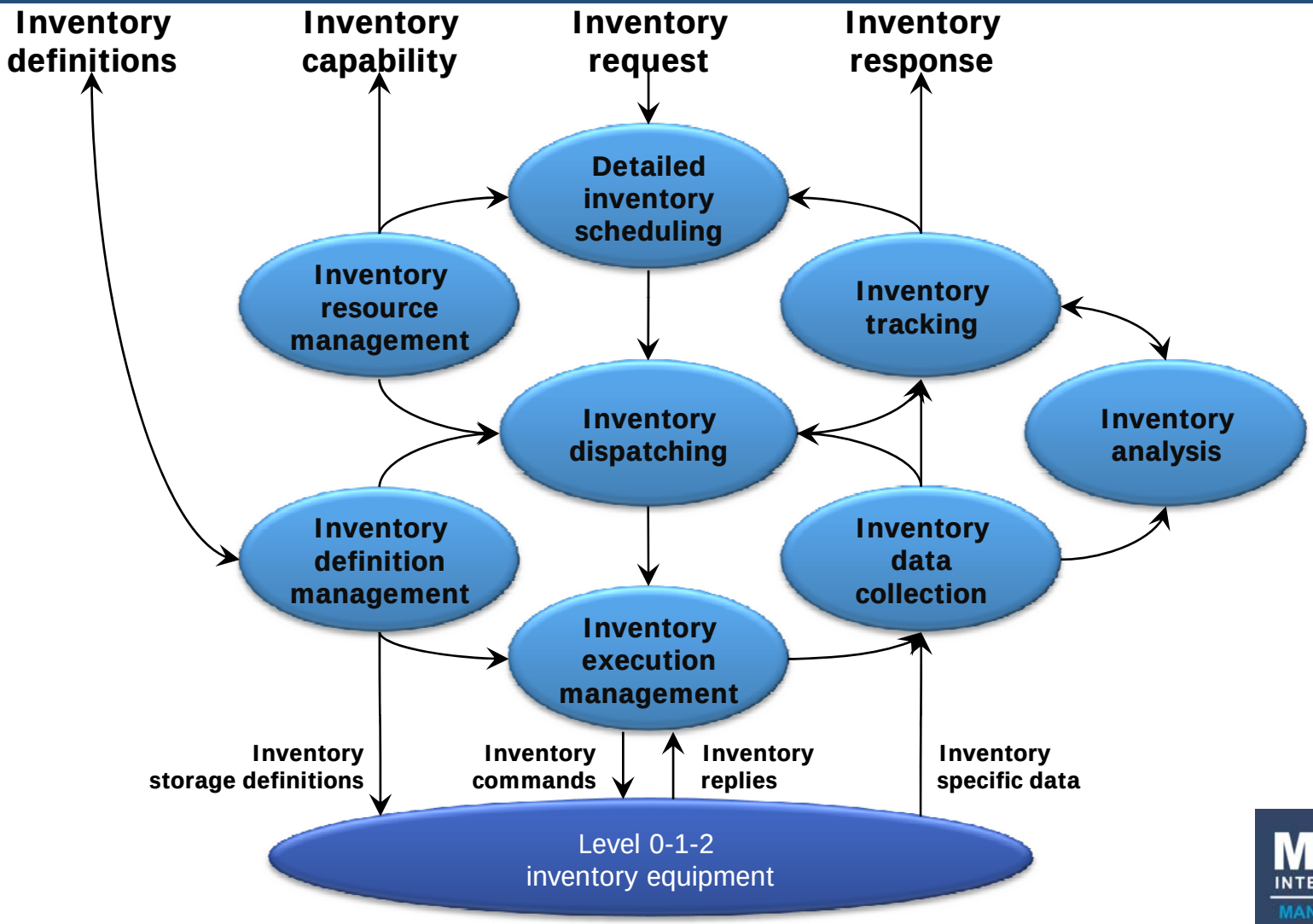
Maintenance Operations



Quality Test Operations



Material Movement and Inventory Transfer Activities



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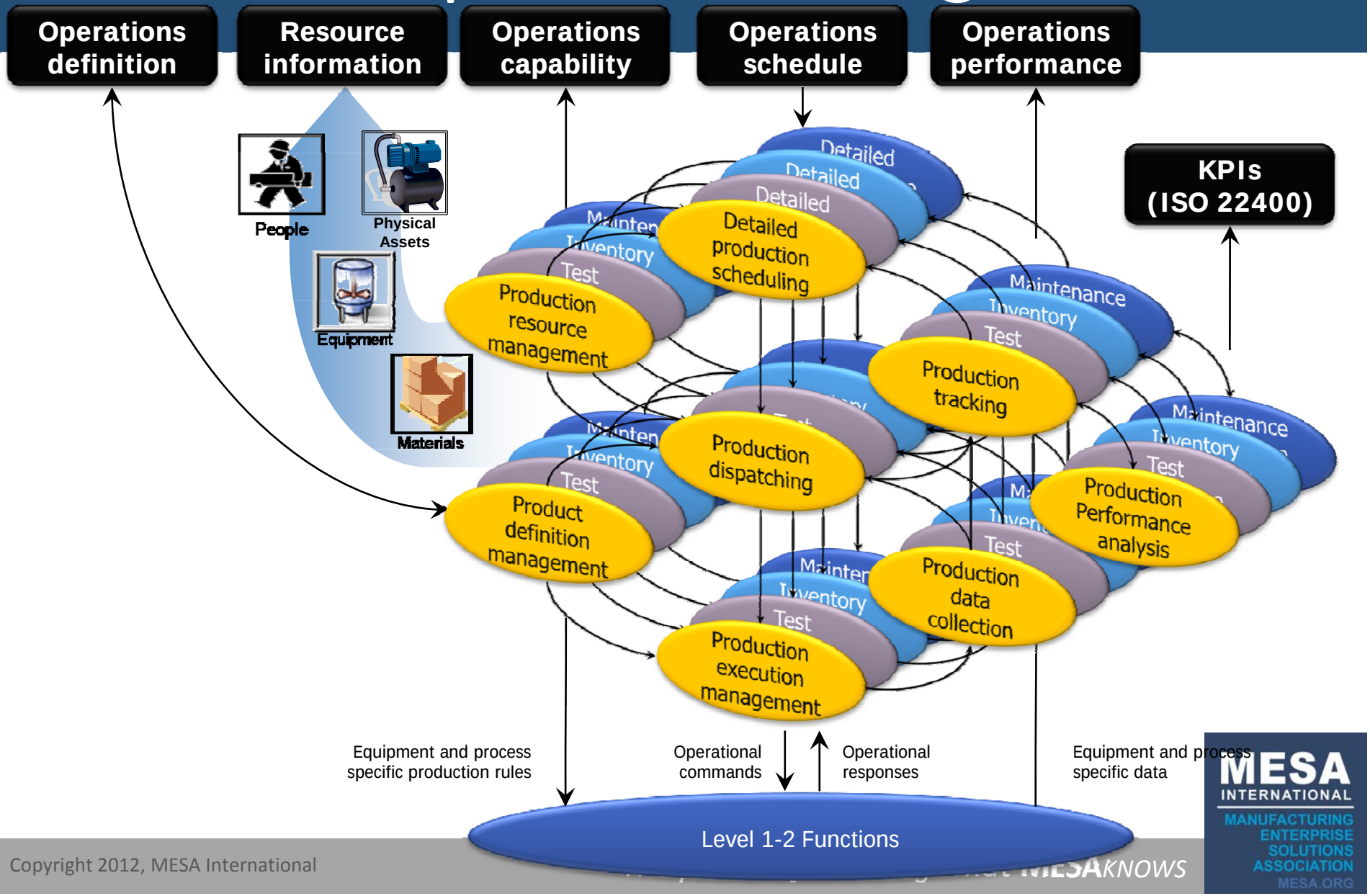
All Operations Categories



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ISA 95
Requirements for MOM

- The ISA 95 Part 3 standard defines about > 80% of the activities that occur in Manufacturing Operations Management (MOM)
  - Production Operations Management
  - Maintenance Operations Management
  - Laboratory (Quality) Operations Management
  - Material Handling & Storage (Inventory) Operations Management
  - Supporting activities
    - Management of security
    - Management of information
    - Management of configuration
    - Management of documents
    - Management of regulatory compliance
    - Management of incidents and deviations

- Activities are used as a map to identify MOM requirements

ISA 95.03 Format

- Part 3 defines the tasks and activities for all 4 categories of MOM
  - It is a straight forward process to convert these into requirements
- Most MOM/MES users are using this outline to generate their MOM requirements
  - Not all projects cover all categories
  - Not all projects cover all activities within a category

6 Production operations management ... 22
6.1 General activities in production operations management ... 22
6.2 Production operations management activity model ... 23
6.3 Information exchange in production operations management ... 24
6.4 Product definition management ... 24
6.5 Production resource management ... 26
6.6 Detailed production scheduling ... 29
6.7 Production dispatching ... 32
6.8 Production execution management ... 36
6.9 Production data collection ... 37
6.10 Production tracking ... 38
6.11 Production performance analysis ... 40
7 Maintenance operations management ... 45
7.1 General activities in maintenance operations management ... 45
7.2 Maintenance operations management activity model ... 45
7.3 Information exchanged in maintenance operations management ... 46
7.4 Maintenance definition management ... 48
7.5 Maintenance resource management ... 48
7.6 Detailed maintenance scheduling ... 49
7.7 Maintenance dispatching ... 49
7.8 Maintenance execution management ... 50
7.9 Maintenance data collection ... 50
7.10 Maintenance tracking ... 50
7.11 Maintenance analysis ... 50
8 Quality operations management ... 51
8.1 General activities in quality operations management ... 51
8.2 Quality test operations activity model ... 53
8.3 Information exchanged in quality test operations management ... 54
8.4 Quality test definition management ... 56
8.5 Quality test resource management ... 56
8.6 Detailed quality test scheduling ... 57
8.7 Quality test dispatching ... 57
8.8 Quality test execution management ... 58
8.9 Quality test data collection ... 59
8.10 Quality test tracking ... 59
8.11 Quality performance analysis ... 59
8.12 Supported activities ... 60
9 Inventory operations management ... 61
9.1 General activities in inventory operations management ... 61
9.2 Inventory operations management activity model ... 61
9.3 Information exchanged in inventory operations management ... 62
9.4 Inventory definition management ... 63
9.5 Inventory resource management ... 64
9.6 Detailed inventory scheduling ... 65
9.7 Inventory dispatching ... 65
9.8 Inventory execution management ... 65
9.9 Inventory data collection ... 66
9.10 Inventory tracking ... 67

Activities and Tasks

- Standard lists tasks that occur in each activity
- The standard does not specify an architecture or organization
- Task list can be quickly converted into requirements
- Identify which activities are to be supported
- Identify which resources (equipment, personnel, material) are to be supported
- Write requirements using ISA 95 terminology

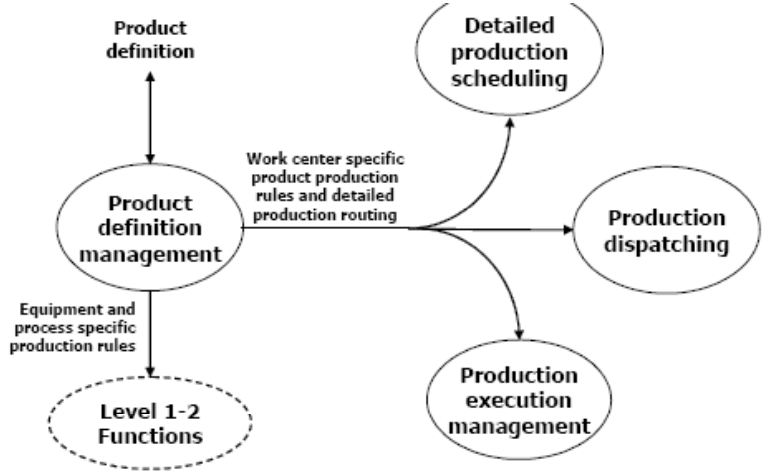


Figure 10 - Product definition management activity model interfaces

6.4.3 Tasks in product definition management

Product definition management tasks may include:

a) Managing documents such as manufacturing instructions, recipes, product structure diagrams, manufacturing bills, and product variant definitions.

b) Managing new product definitions.

c) Managing changes to product definitions. This may include the ability to route designs and manufacturing bill changes through an appropriate approval process, management of versions, tracking of modifications, and security control of the information.

d) Providing product production rules to personnel or other activities.

EXAMPLE:

These may take the form of manufacturing steps, master recipes, machine setup rules, and process flowsheets.

e) Maintaining the feasible detailed production routings for products.

f) Providing the product segment route to manufacturing operations in the level of detail required by manufacturing operations.

g) Managing the exchange of product definition information with Level 4 functions at the level of detail required by the business operations.

h) Optimizing product production rules based on process analysis and production performance analysis.

i) Generating and maintaining local production rule sets indirectly related to products, such as for cleaning, startup, and shutdown.

j) Managing the Key Performance Indicator (KPI) definitions associated with products and production.

NOTE — There are a number of tools to assist in the product definition management activity, including mechanical and electronic computer-aided design (CAD), Computer-Aided Engineering (CAE), and Computer-Aided Software Engineering (CASE), recipe management systems, Computer-Aided Process Engineering (CAPE), and Electronic Work Instructions (EWIs).

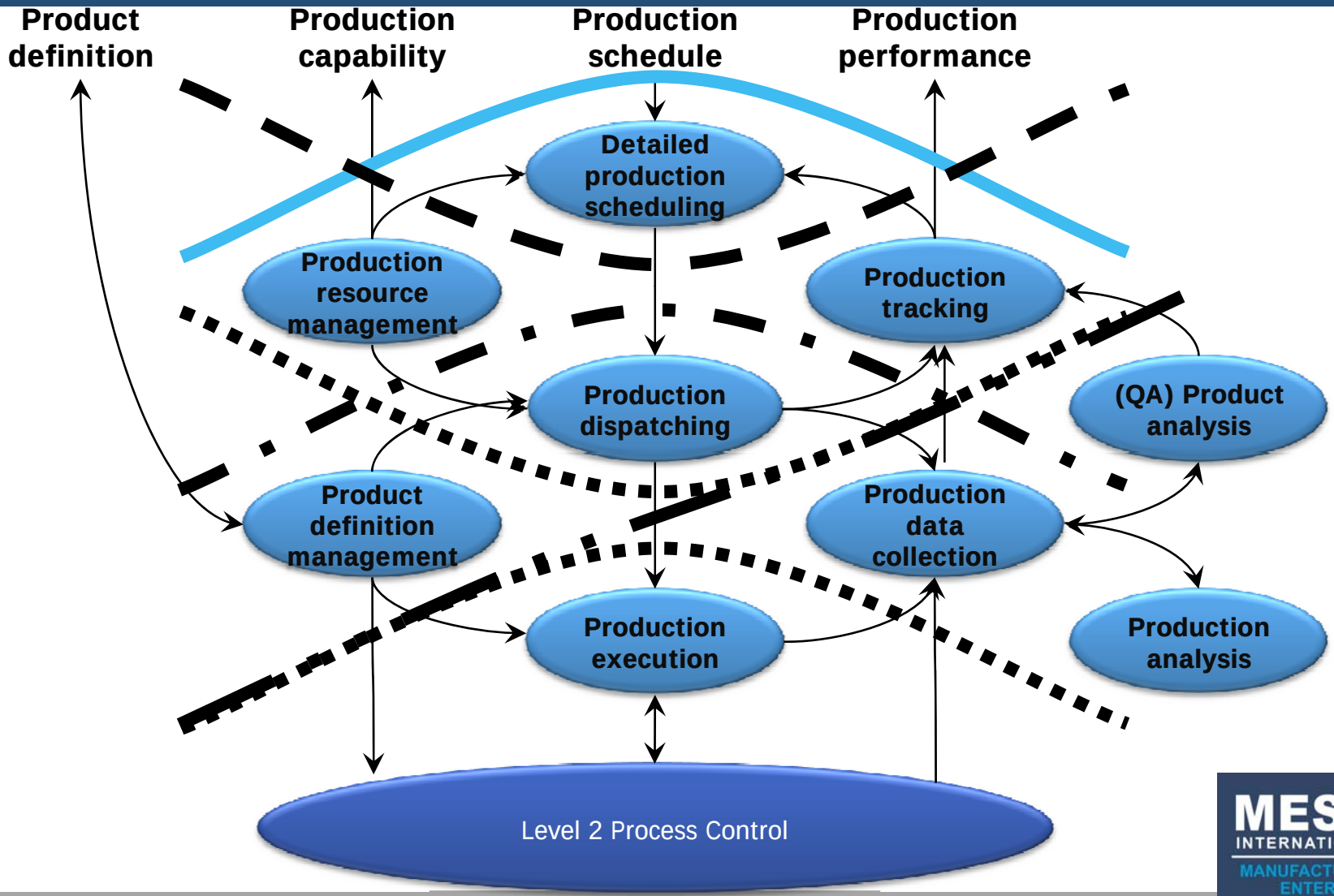
ISA 95 Part 3 - Template for User Requirement Specifications

- Typical end user requirements (URS)
- Being used to compare different vendor's functionality and capabilities
- We finally have a vendor independent description of MOM/MES
- We finally have a common way to compare different facilities

Table of Contents

1 INTRODUCTION....6
2 SUMMARY....12
3 PROCESS DESCRIPTIONS....15
3.1 SYSTEM OVERVIEW....15
3.2 AREA 1....17
3.3 AREA 2....27
4 REQUIREMENTS SPECIFICATIONS....52
4.1 GENERAL FUNCTIONAL REQUIREMENTS....54
4.1.1 Production Equipment Management Requirements....54
4.1.2 Production Material Management Requirements....55
4.1.3 Production Personnel Management Requirements....58
4.1.4 Production Recipe Management Requirements....58
4.1.5 Detailed Production Scheduling Requirements....61
4.1.6 Production Dispatching Requirements....63
4.1.7 Production Execution Requirements....64
4.1.8 Production Data Collection Requirements....68
4.1.9 Production Tracking Requirements....69
4.1.10 Production Analysis Requirements....71
4.2 PROCESS AREA SPECIFIC REQUIREMENTS....72
4.2.1 Area 1 Requirements....72
4.2.2 Area 2 Requirements....72
4.3 NON-FUNCTIONAL REQUIREMENTS....78
4.3.1 Management of Security....78
4.3.2 Management of Information....79
4.3.3 Management of Configurations....80
4.3.4 Management of Documentation....80
4.3.5 General Compliance Requirements....80

MOM Boundary Defines the Requirement's scope



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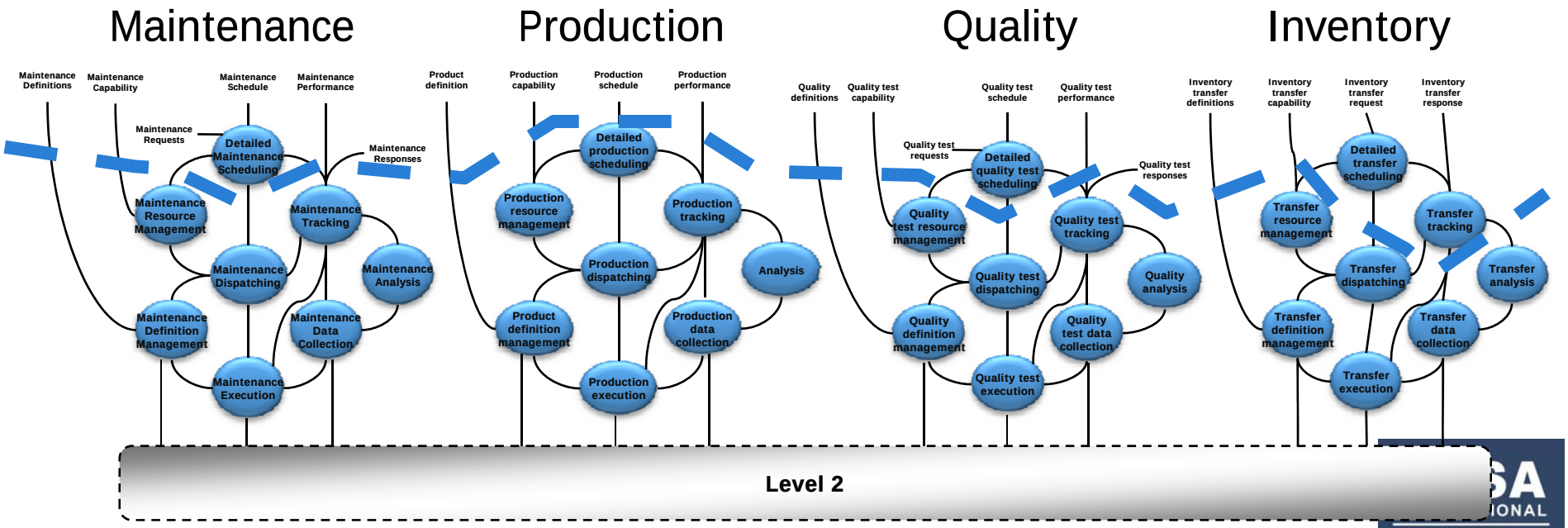
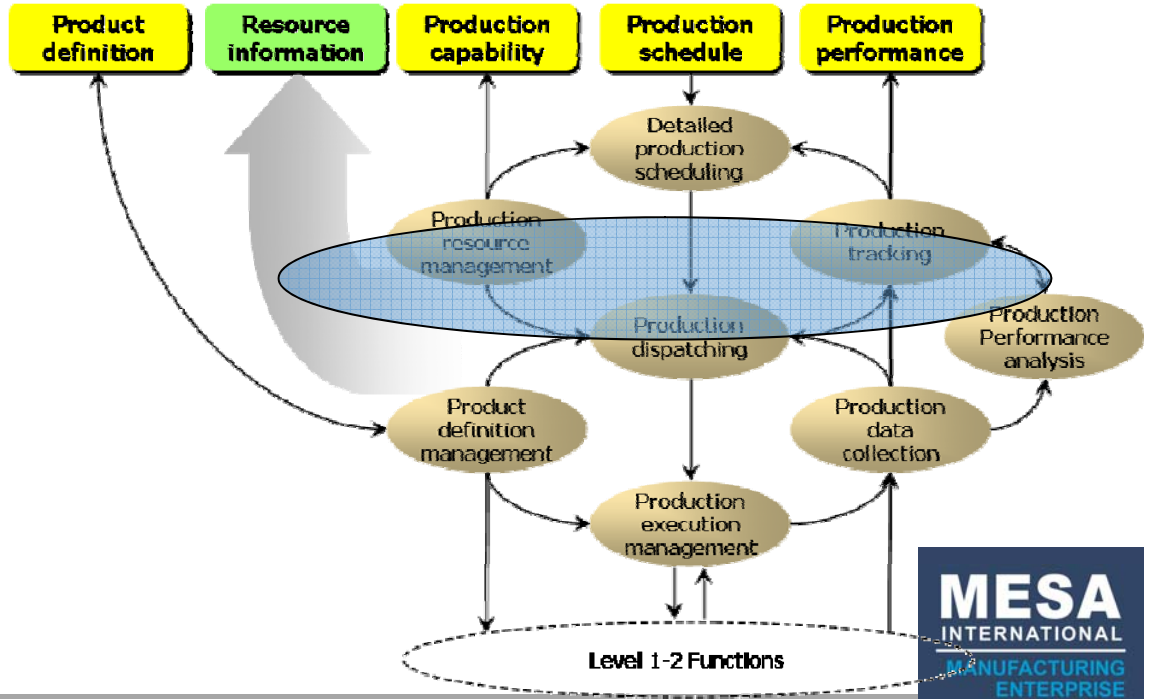
For All Categories

- Determine which areas are covered by the implementation
- Most implementations cover 1 or 2 categories
- Determine the line of responsibility for each category



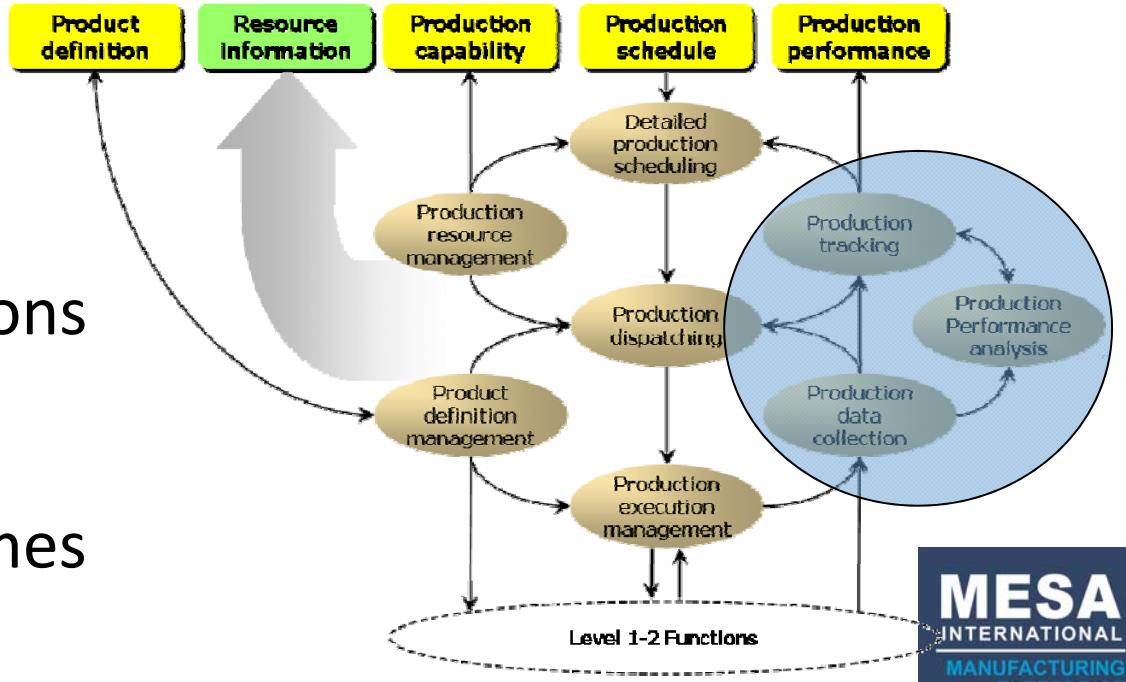
Example: Equipment / Vessel Tracking

- At a process company one main issue was tracking transfer vessels, their status (clean, sterile, in use, …) and location (in plant and between plants)
- Limited MES installed to track equipment resources
- Reduced delays due to vessel availability and eliminated errors due to incorrect equipment



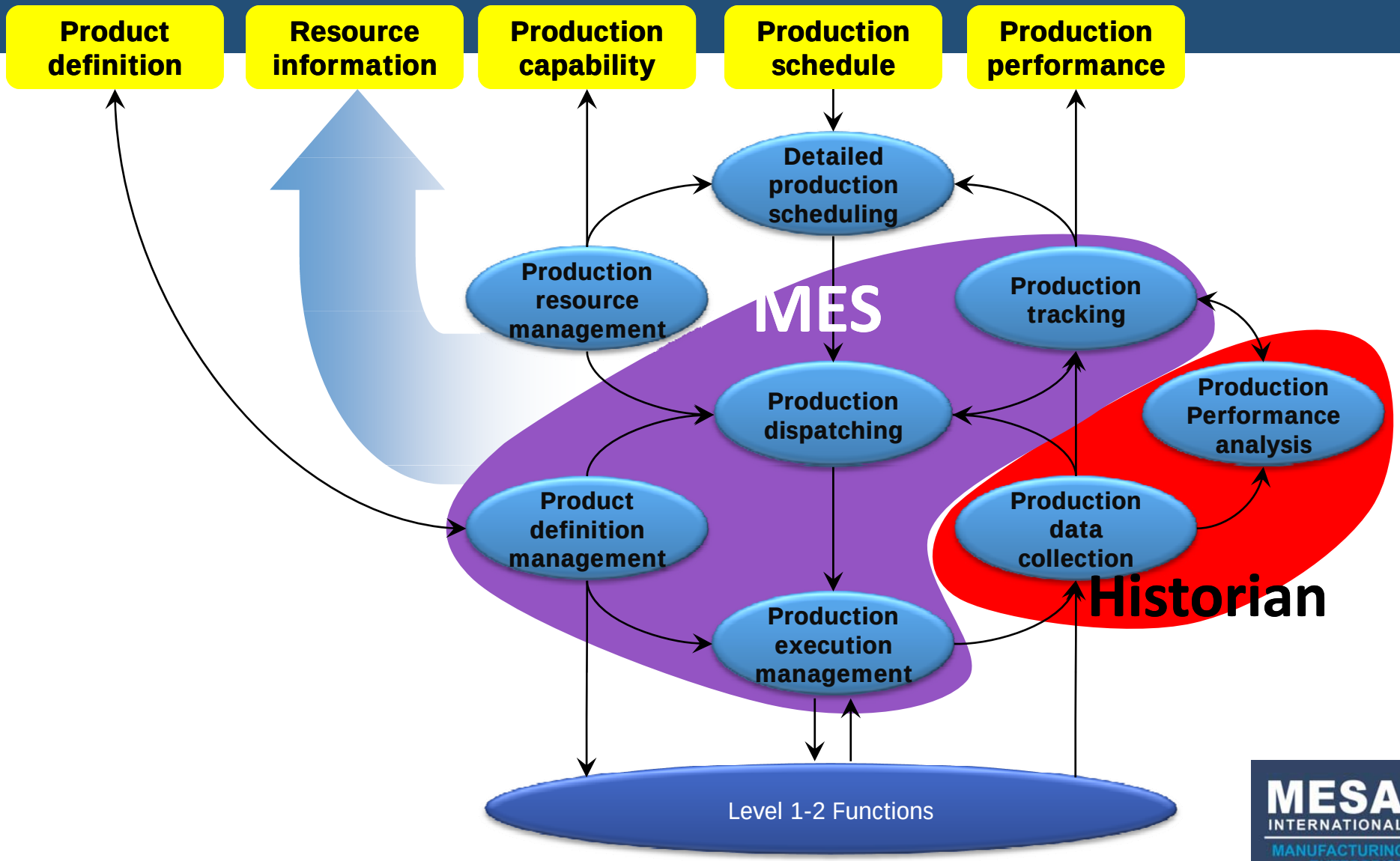
Example: Investigations & RFT Studies

- Major company's goal was reduce incident investigation time & RFT study time, >80% spent collecting data
- Installed a limited MES for Data Collection & Analysis



- Initial implementations have significantly reduced study and investigation times

Typical Initial MES Implementation



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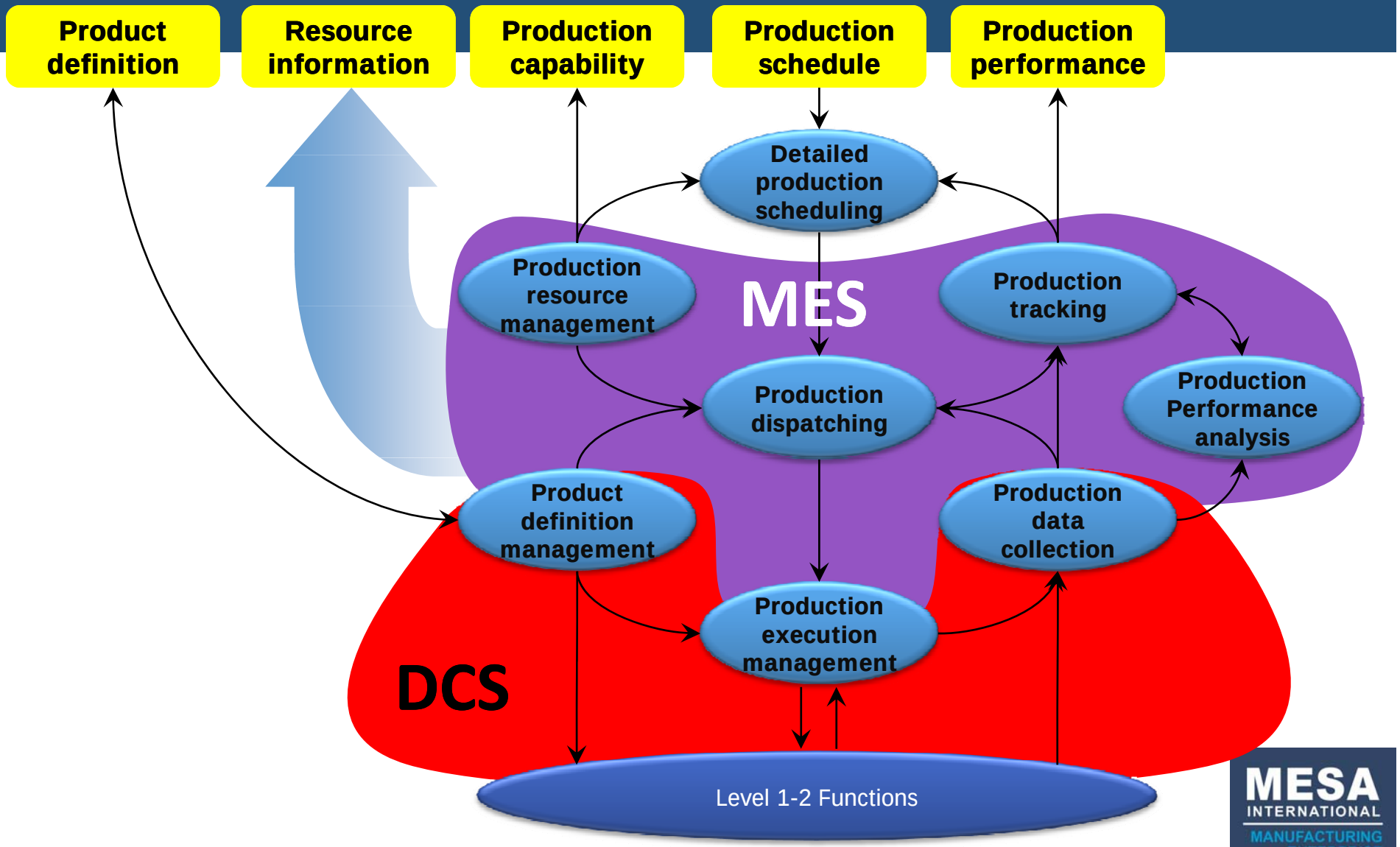
The Typical MES / DCS Pattern



Commercial MOM/MES Systems

- Mostly based on ISA 95 and ISA 88 standards
- Most solutions still focused on industry segments
  - Pharmaceutical
  - Automotive
  - Discrete Assembly
  - Food and Beverage
  - Process Industries
- Site implementations range from 200K – 2M USD depending on scope and customization required
- Paybacks come from 2%-3% year to year productivity improvements
  - Because of ability to “lock-in” best practice procedures

Summary

- ISA 95 provides a vendor independent description of MOM/MES
- Provides a vendor independent and user independent format for MOM requirements
- Vertical integration of system is usually required to achieve full MOM benefits
- Well documented benefits from MOM implementations are driving additional implementations
- Most vendors are supporting the ISA 95 standard and are using it to describe their products' functionality

ISA 95 / MOM / B2MML Questions

Thank you

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THEY KNOW THEY HAVE A RESPONSIBILITY TO INDUSTRY AND TO ONE ANOTHER.
THEY KNOW THE CONSEQUENCES OF AVOIDING A SINGLE IMPROVEMENT CAN MEAN MILLIONS OF DOLLARS AND A POSSIBLE GLOBAL IMPACT.
THEY KNOW THE POWER OF KNOWING WHAT MESA KNOWS.

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