Work: **ISA8895 Implementation**

Section: **Overview**

Chapter: **Modelling**

Language: **English**

Version: **V3 - 05/2011**

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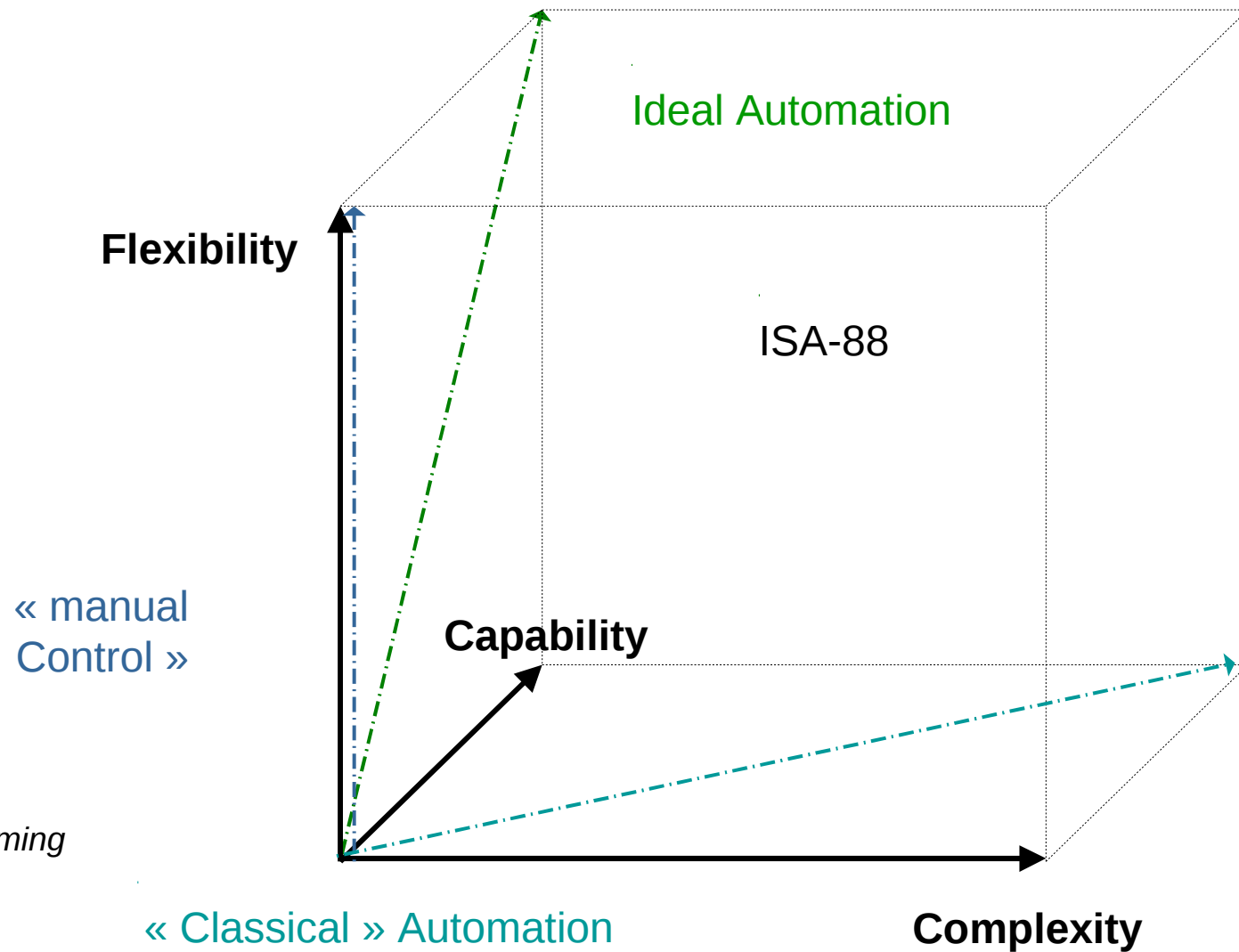
CCM Research community   www.controlchainmanagement.org
CCG Consulting group   www.controlchaingroup.com

Agenda

- **ISA-88 snapshot**
- **ISA-95 snapshot**
- **IIPS Lifecycle**
- **CCM modelling framework**
- **ISA-88/95 based Models and Objects**
- **ISA-88/95 in Production Lifecycles**
- **Methodology**

Automation challenge

Ideal Automation

Flexibility

ISA-88

« manual Control »

Capability

Darin Flemming
Lou Pillai

« Classical » Automation

Complexity

ISA-88 standard

- **US and International "Batch Control" standard**
- **The ISA88 committee develops the US ANSI standard**
- **The IEC65A WG11 develops the IEC international standard**

US standard	INTL Standard	Sub Title
ANSI/ISA-88.00.01: 2010	IEC 61512-1: 1997	Part 1: Models and Terminology"
ANSI/ISA-88.00.02: 2001	IEC 61512-2: 2001	Part 2: Data structures and guidelines for languages
ANSI/ISA-88.00.03: 2003	IEC 61512-3: 2008	Part 3: General and Site Recipe - Models and Representation
ANSI/ISA-88.00.04: 2006	IEC 61512-4: 2009	Part 4: Batch Production Records
ISA Draft88.00.05	-	Part 5: Implementation Models & Terminology for Modular Equipment Control

ISA-88 snapshot

- **Object Design of automation applications**
  - Reuse, Knowledge Management, Robustness
- **Flexible Design of automation applications - No programming required for**
  - Modification of recipes, making different products with the same facility
  - Using alternate equipment for the same production step
  - Sequencing production runs for different products
- **Interoperability**
  - Assembling software components from different origins
- **Product Industrialization**
  - Neutral specification of product physico-chemical transformations
  - Conversion of this specification into operating procedure for target facilities
- **Production Information**
  - Data structures for production information history
  - Includes several ISA-95 models
- **Applications**
  - Initially designed for Batch processes, but applicable to any type of process
  - Functional specification, batch managers, historians, PDM/PLM

ISA-88 Adoption

- **Automation Functional Engineering Good Practices**
  - ➤ Largely applied worldwide, proven benefits
- **Best known in process industries**
  - ➤ Less in other domains…
- **All automation vendors offer solutions**
  - ➤ Generally limited to the support of recipes (authoring, execution, reporting)
  - ➤ Sometime at the equipment control level
- **Applies more and more to all types of production**
  - ➤ No equivalent standards for discrete and continuous processes…
  - ➤ Adapt easily
  - ➤ Most benefits with globalized application: all types of processes, all locations

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ISA-95 snapshot

- **B2M: Collaboration Business / Execution**
  - Communication between execution systems (MES/MOM, DCS, MMS, LIMS, WES, SCADA,…) and business systems (ERP, SCM)
  - Master data management
- **MES/MOM : Functional definition**
- **Data and Activity models**
  - Description of resources, capability, products, work order requests and reports
  - Definition of operation management activities (MES)
- **Applications:**
  - User requirements and functional specification of MES and B2M interfaces
  - Native B2M connectors - MES/ERP (B2MML)
  - Possible basis for developing MES applications and software…

What is ISA-95?

- **US & International standard "Enterprise - Control System Integration"**
- **The ISA95 committee develops the ISA-95 standards**
- **The ISO/IEC JWG5 develops the international standard**

US standard	INTL Standard	Sub Title
ANSI/ISA-95.00.01: 2010	IEC/ISO 62264-1: 2003	Part 1: Models and Terminology"
ANSI/ISA-95.00.02: 2010	IEC/ISO 62264-2: 2004	Part 2: Data Structures and Attributes"
ANSI/ISA-95.00.03: 2005	IEC/ISO 62264-3: 2007	Part 3: Activity Models of Manufacturing Operations Management
ISA draft 95.00.04	-	*(Part 4: Object Models and Attributes of Manufacturing Operations Management)*
ASNI/ISA-95.00.05: 2007	IEC/ISO 62264-5: 2010 (APUB)	Part 5: Business to Manufacturing Transactions

Benefits and adoption of ISA-95

- **Benefits:**
  - ➢ Direct : Cost and risk reduction of MES and B2M projects
  - ➢ Indirect :
    - ▪ Improvement of operational performance : CTP, agile manufacturing, planning feedback, error reduction
    - ▪ Dynamization of IT/Business alignment
- **Adoption:**
  - ➢ Most automation / MES vendors claim their adhesion to ISA95
  - ➢ ERP vendors ignore it
    - ▪ Noticeable exception: SAP since 2004
  - ➢ B2MML becomes the de facto standard for B2M information exchange

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CCM global IIPS life cycle

IIPS : Industrial Information Processing Systems

CCM global IIPS life cycle

Information Service Definition

- Industrial Architecture
- User Requirements

IT Resource Development

- IIPS Construction
- IIPS Deployment

- IIPS Support Maintenance
- IIPS Operation

Run-time Information Processing
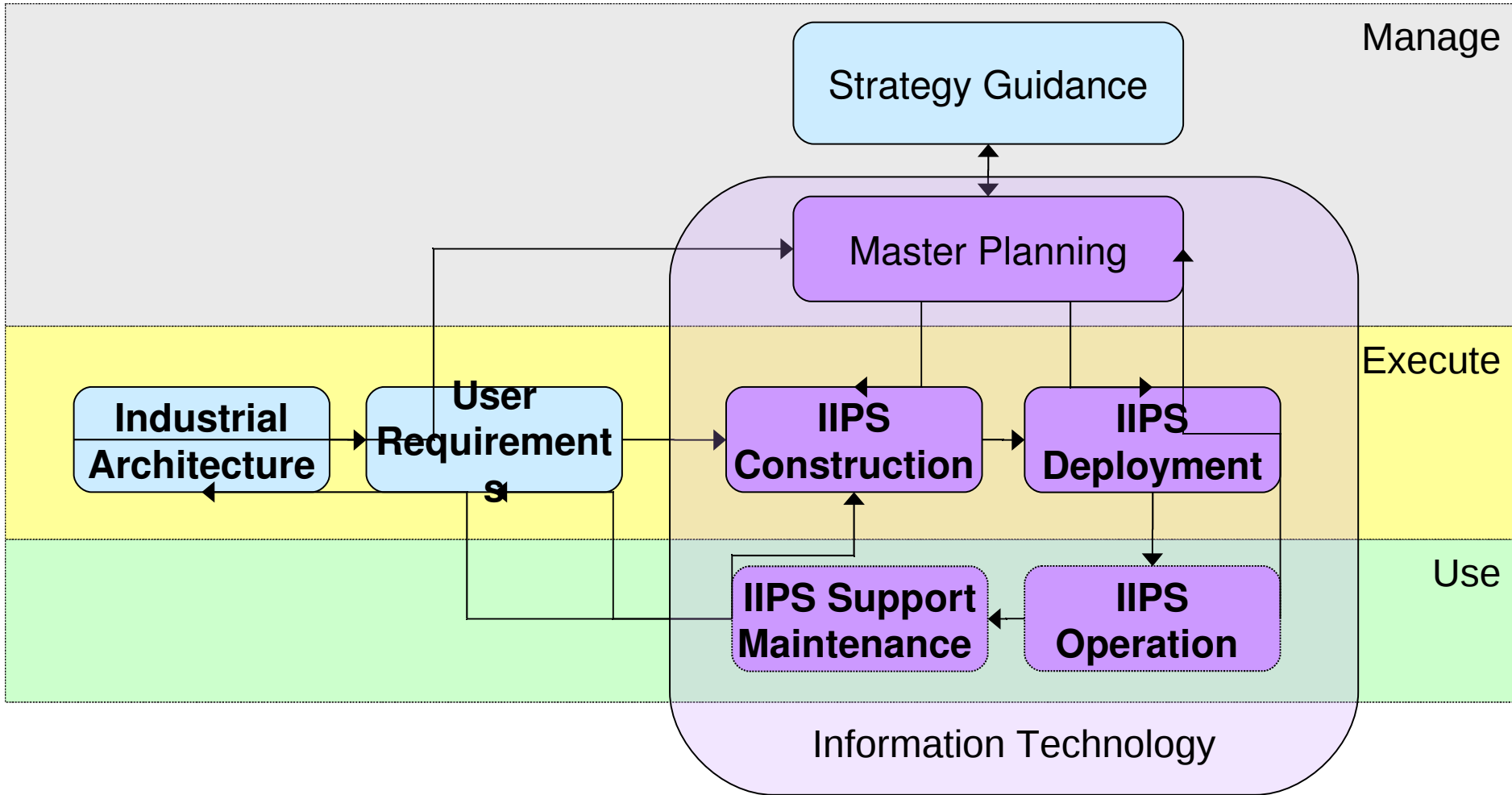
ISA-95 like IIPS life cycle

Run-time Information Processing

Information Service Requests

Information Services Requests

Information Services (BP)

Information Services (Task)

Information Service Definition

Information Services (implemented)

Information Services Capability

Resources
HW, SW, DWH

IT Resource Development
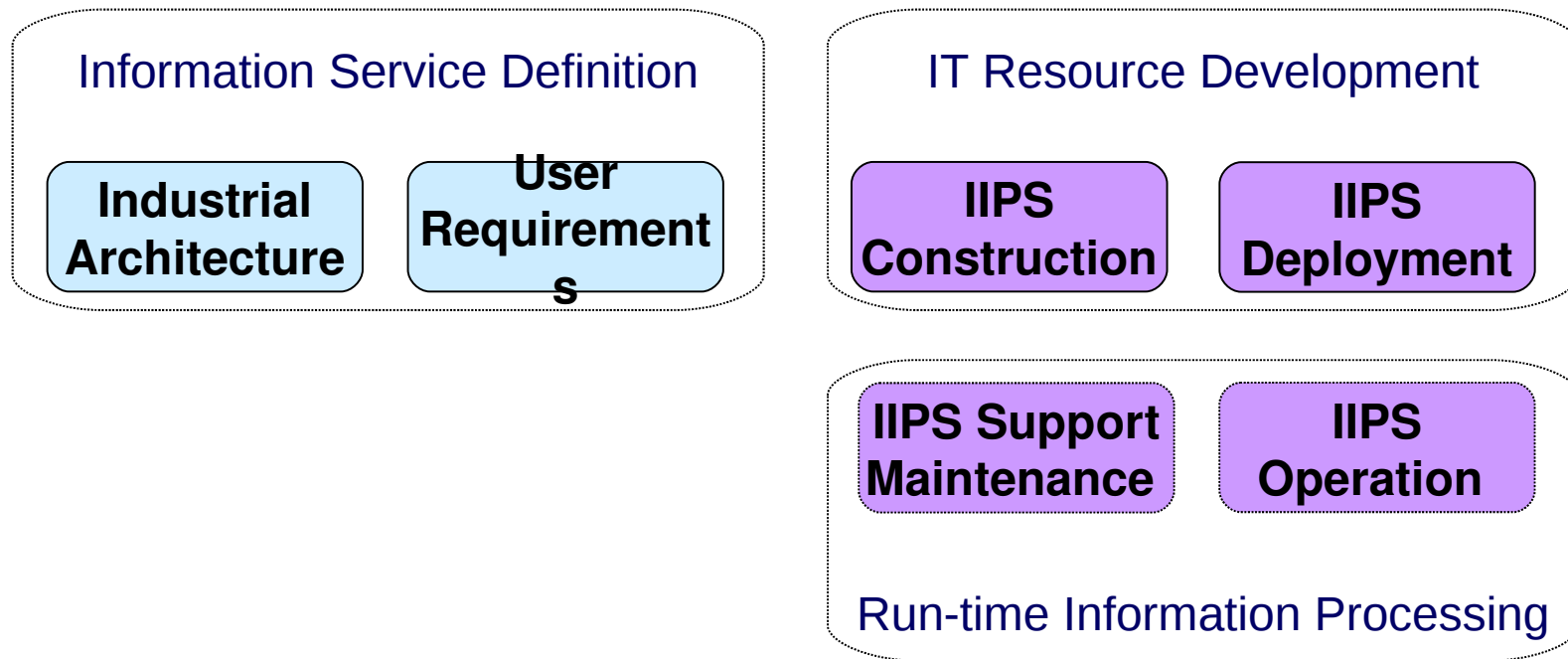
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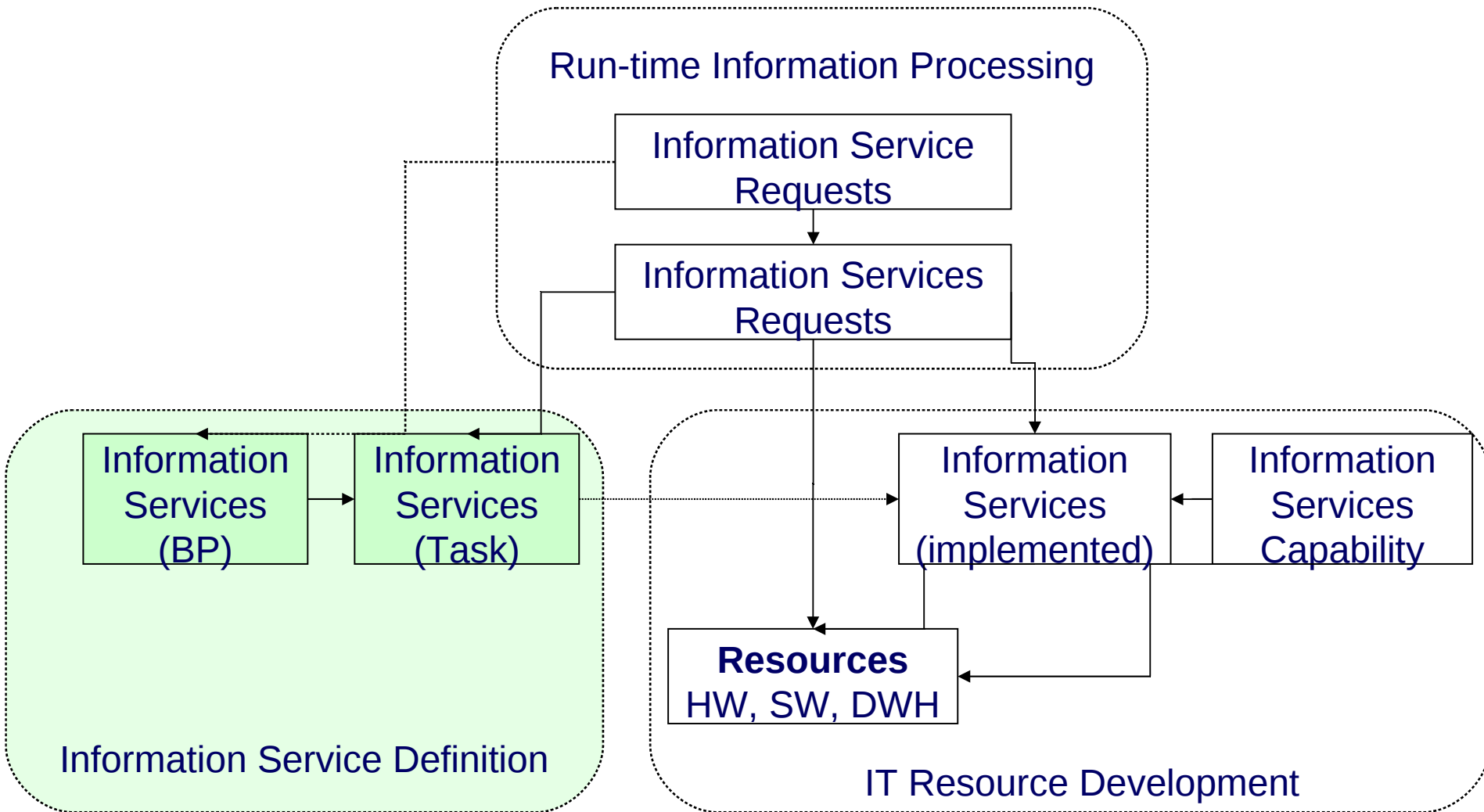- **ISA-88/95 in Production Lifecycles**
- **Methodology**

Industrial Architecture Models Purpose

- **Scope**
  - The entire industrial facility – the Production sub-system within the Enterprise system
  - Spatio-temporal description (structures and interactions) of this sub-system
  - The information reality that tights Energy and Matter together
- **Ongoing maintenance**
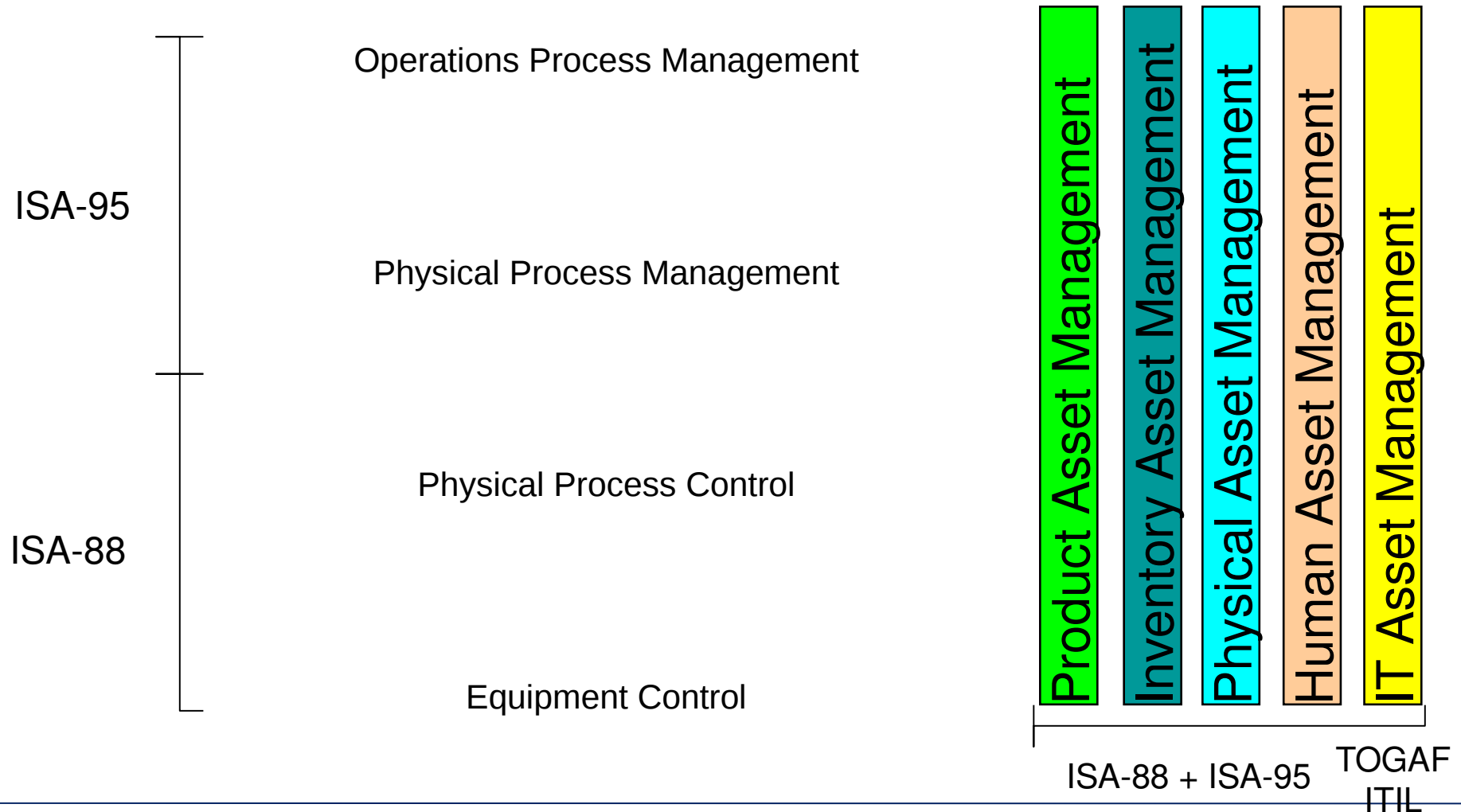 - This module only presents models for describing the facility
  - However, the facility is ever changing.
    - The Industrial Architecture Processes (IAP) integrates IAM within the global enterprise strategy definition and fulfillment process
- **IAM provides the framework**
  - For capturing and managing knowledge
  - For mastering IIPS development planning

Industrial Architecture Dimensions

IIPS Scope in Industrial Architecture framework

Business Information Processing Systems

Marketing, R&D, HR, Engineering, Sales, Purchasing, Finance/accounting, planning

Industrial Information Processing Systems

Operations Process Management
Resource & Definitions Management
Scheduling, Dispatching,
Analysis, Performance, Tracking, Reporting

Physical Process Management
Work Segments & Resources

Physical Process Control
Operating procedures, Routings, Recipes

Equipment Control
Basic, Procedural, Coordination Control

ISA95

Production
Inventory, Logistics
Quality
Maintenance
Tooling
…

ISA 88

Risk & Safety
Information
Configurations
Documentation
Regulation
Incidents & Deviations
…

Common IT systems involved
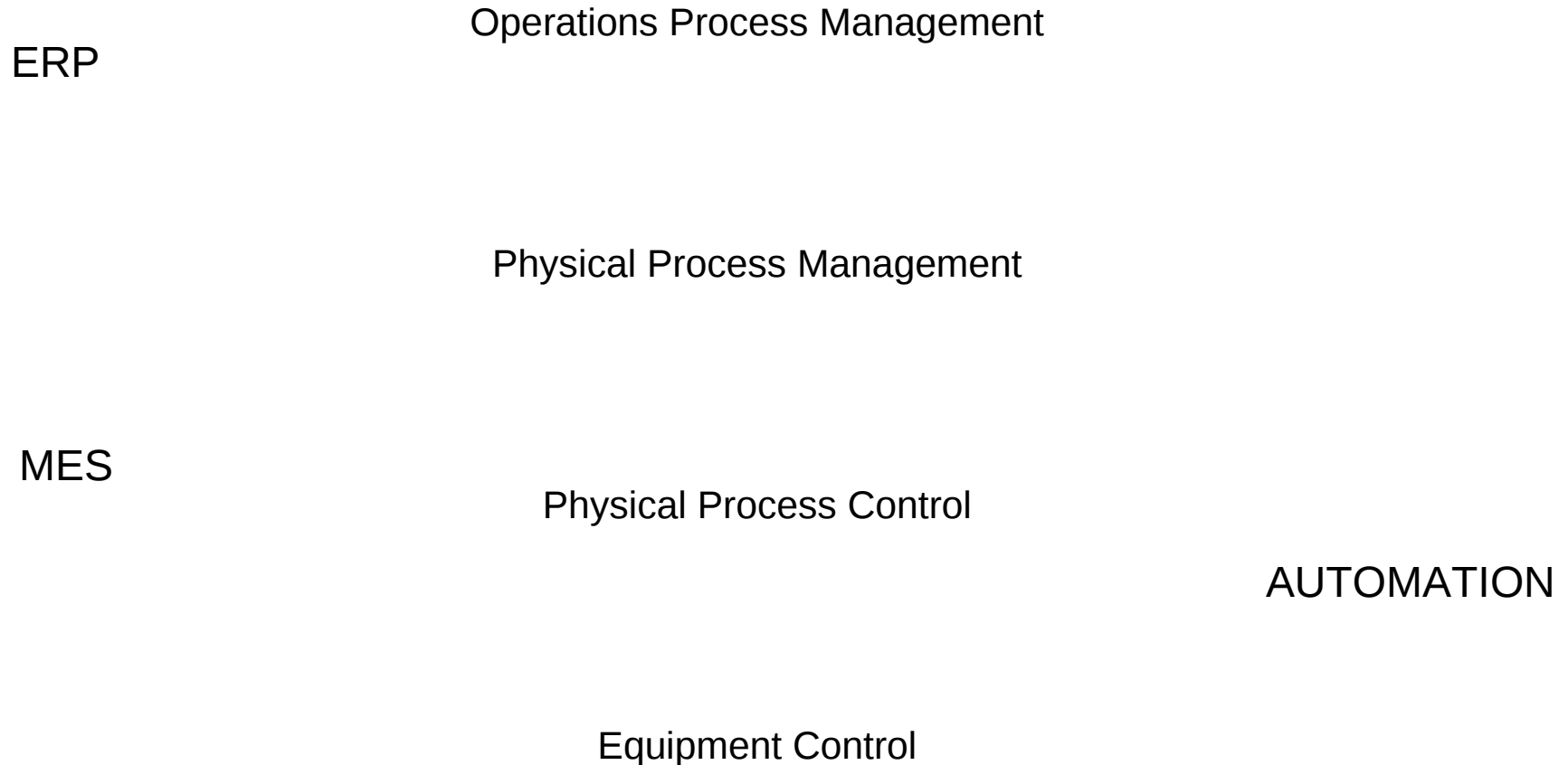
ERP

Operations Process Management

Physical Process Management

MES

Physical Process Control

AUTOMATION

Equipment Control

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ISA88 Process model (Processing Requirement)

Process

A **Process** is made up of an ordered set of one or more **Process Stages**

Process Stage

A **Process Stage** is made up of an ordered set of one or more **Process Operations**

Process Operation

A **Process Operation** is made up of an ordered set of one or more **Process Actions**

Process Action
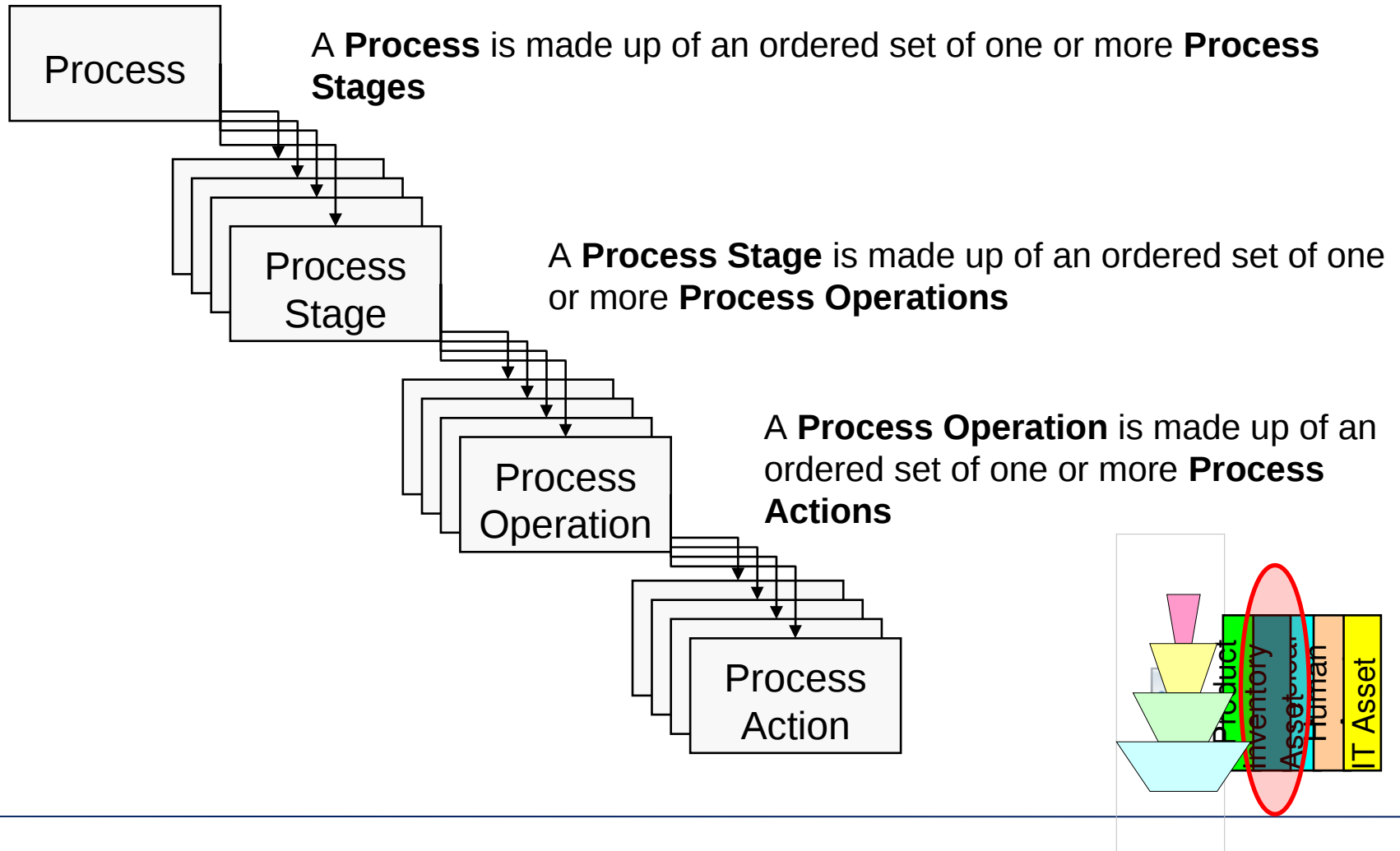
Resource models (Structural description)

- **The resource asset models (Personnel, Equipment, and Material) are based on the ISA-95 breakdown.**
- **All these resources share a similar pattern. Equipment and Material are indeed the same entity: A "machine" can be:**
  - ➢ A "Physical Asset" for the company that makes products with it,
  - ➢ An "Inventory Asset" for the company that makes them (finish product) or sell / distributes it
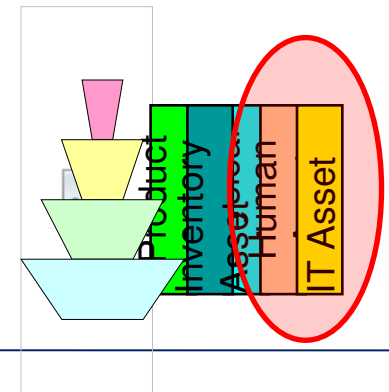
ISA-95 Material Model
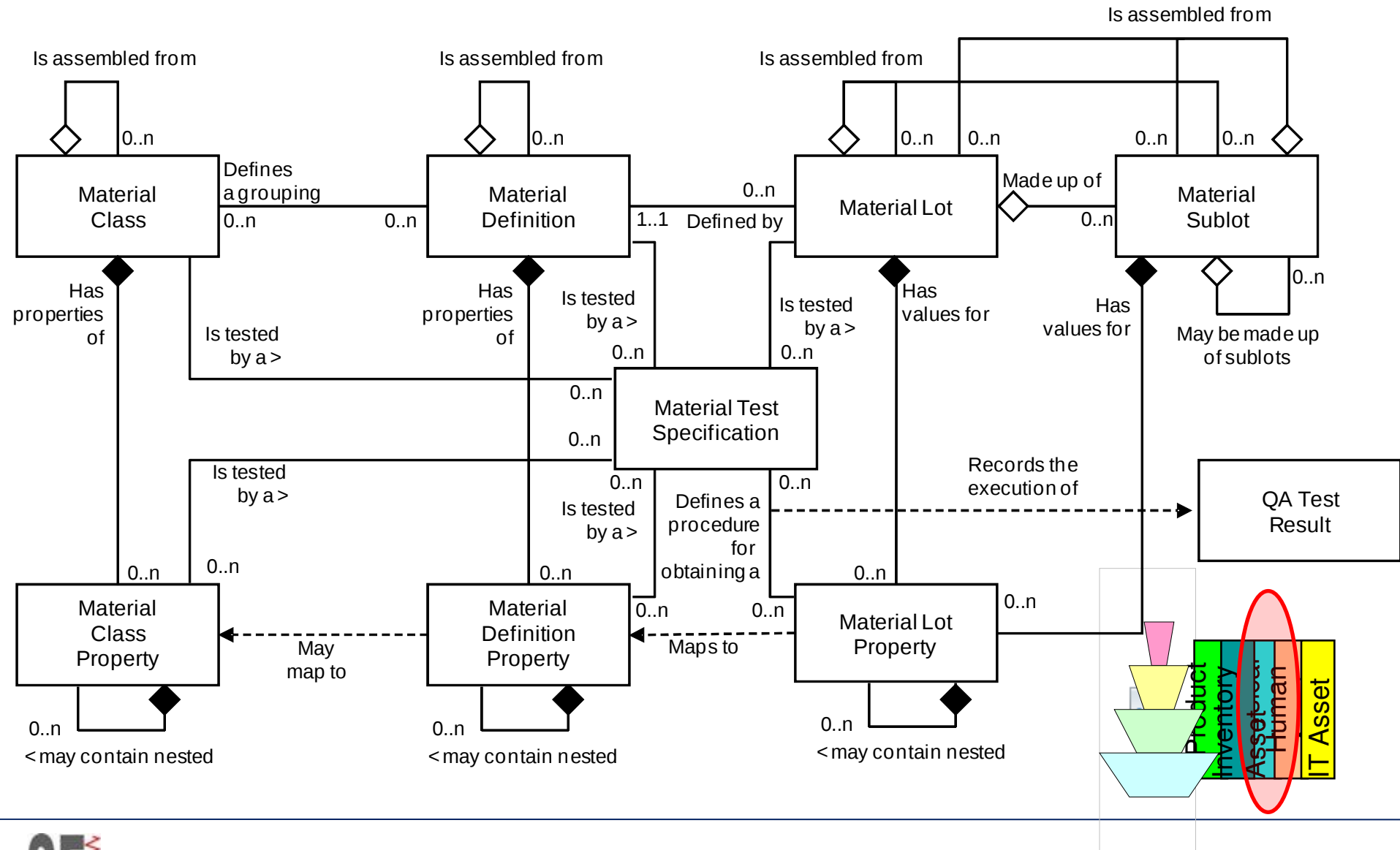
ISA-95 extended physical model (Actual Facility layout)

	BATCH PROCESS (ISA88)	CONTINUOUS PROCESS	DISCRETE PROCESS	WAREHOUSE
ENTERPRISE				
SITE				
AREA				
WORK CENTER	PROCESS CELL	PRODUCTION UNIT	PRODUCTION LINE	STORAGE ZONE
WORK UNIT	UNIT	UNIT	WORK CELL	STORAGE UNIT
EQUIPMENT MODULE				
CONTROL MODULE				

Product Inventory Asset Human IT Asset

ISA-95 Equipment Model

< May be made up of

0..n

Equipment Class

0..n

0..n

Equipment

< Defined by

Has properties of >

0..n

Is tested by an >

0..n

Is tested by an >

0..n

Has values for >

0..n

Equipment Capability Test Specification

0..n

0..n

< Records the execution of

Equipment Capability Test Result

Is tested by an >

Defines a procedure for obtaining an >

0..n

Equipment Class Property

0..n

Maps to

0..n

Equipment Property

0..n

0..n

< may contain nested

< may contain nested

ISA-95 Personnel Model

```
Personnel                    0..n              0..n       Person
Class                        < Defined by

                   0..n
                   Is tested          0..n
         Has       by a >             Is tested         Has
      properties                      by a >            values for >
         of >

                        0..n                0..n
                          Qualification
                             Test
                          Specification

                        0..n                0..n         < Records the
                                                           execution of
                                Defines a
                    Is tested   procedure for
      0..n          by a >      obtaining a >                 0..n
    Personnel                                                           Qualification
  Class Property  0..n                        0..n      Person              Test
                                                        Property           Result
                           < Maps to
```

ISA-88 Procedural Control model (Equipment/Product Interactions)

Procedure

A **Procedure** is made up of an ordered set of one or more **Unit Procedures**

Unit Procedure

A **Unit Procedure** is made up of an ordered set of one or more **Operations**

Operation

An **Operation** is made up of an ordered set of one or more **Phases**

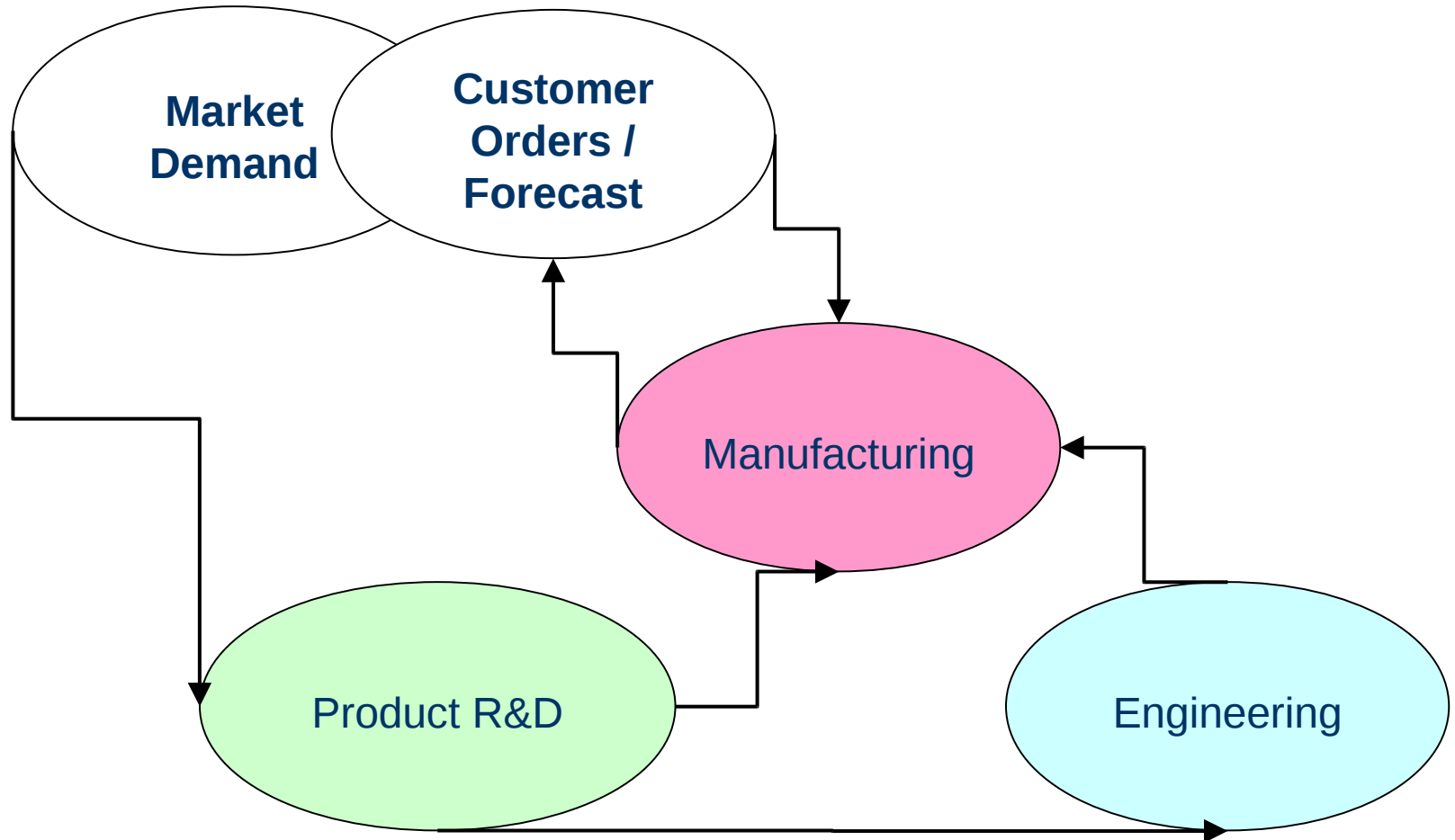**Phase**
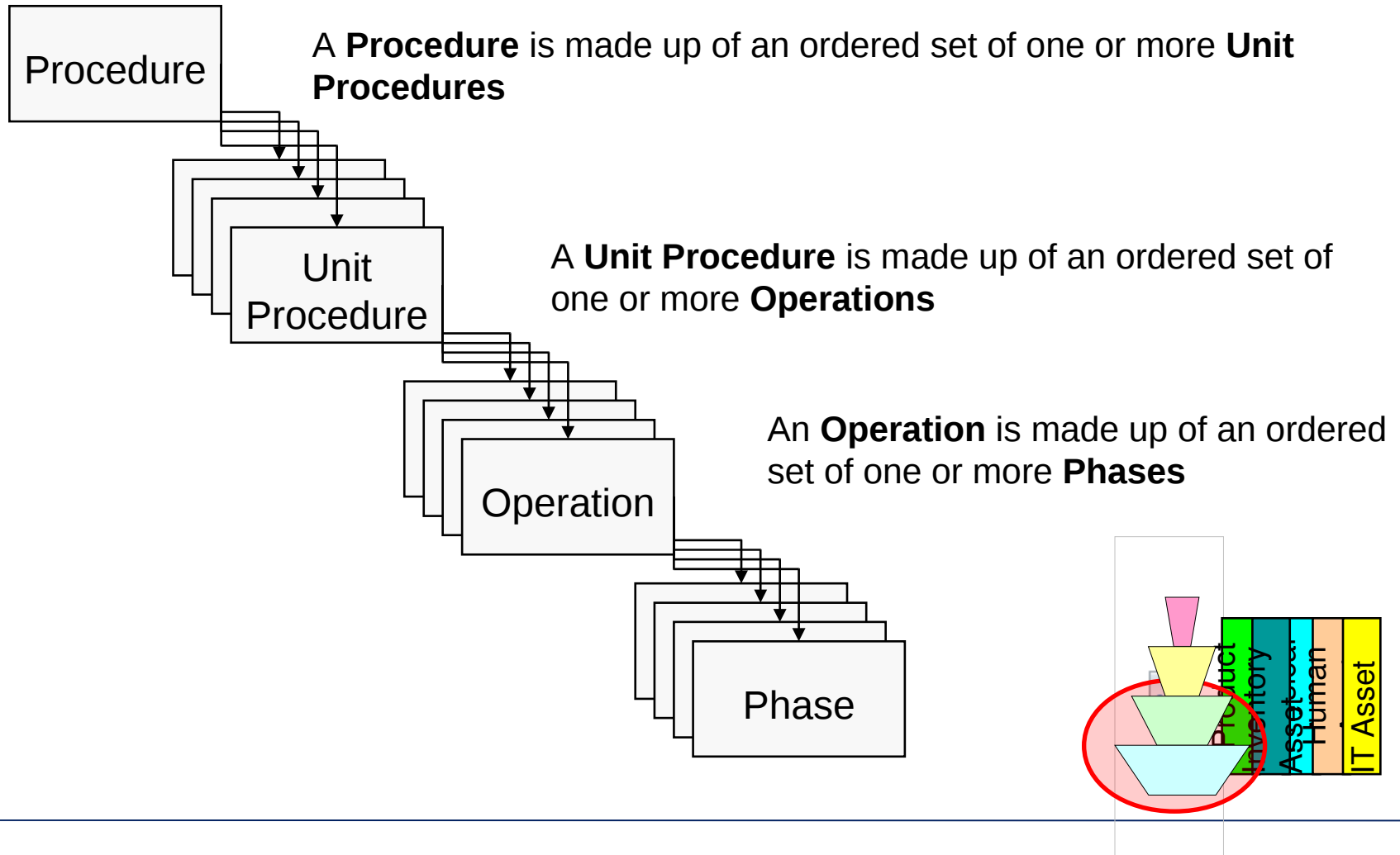
ISA-95 Segment Model
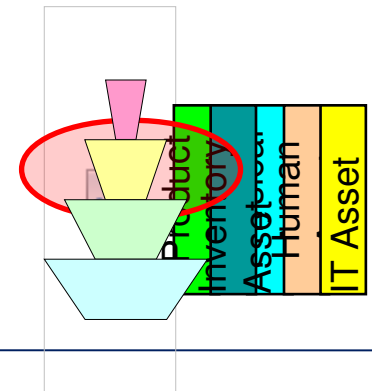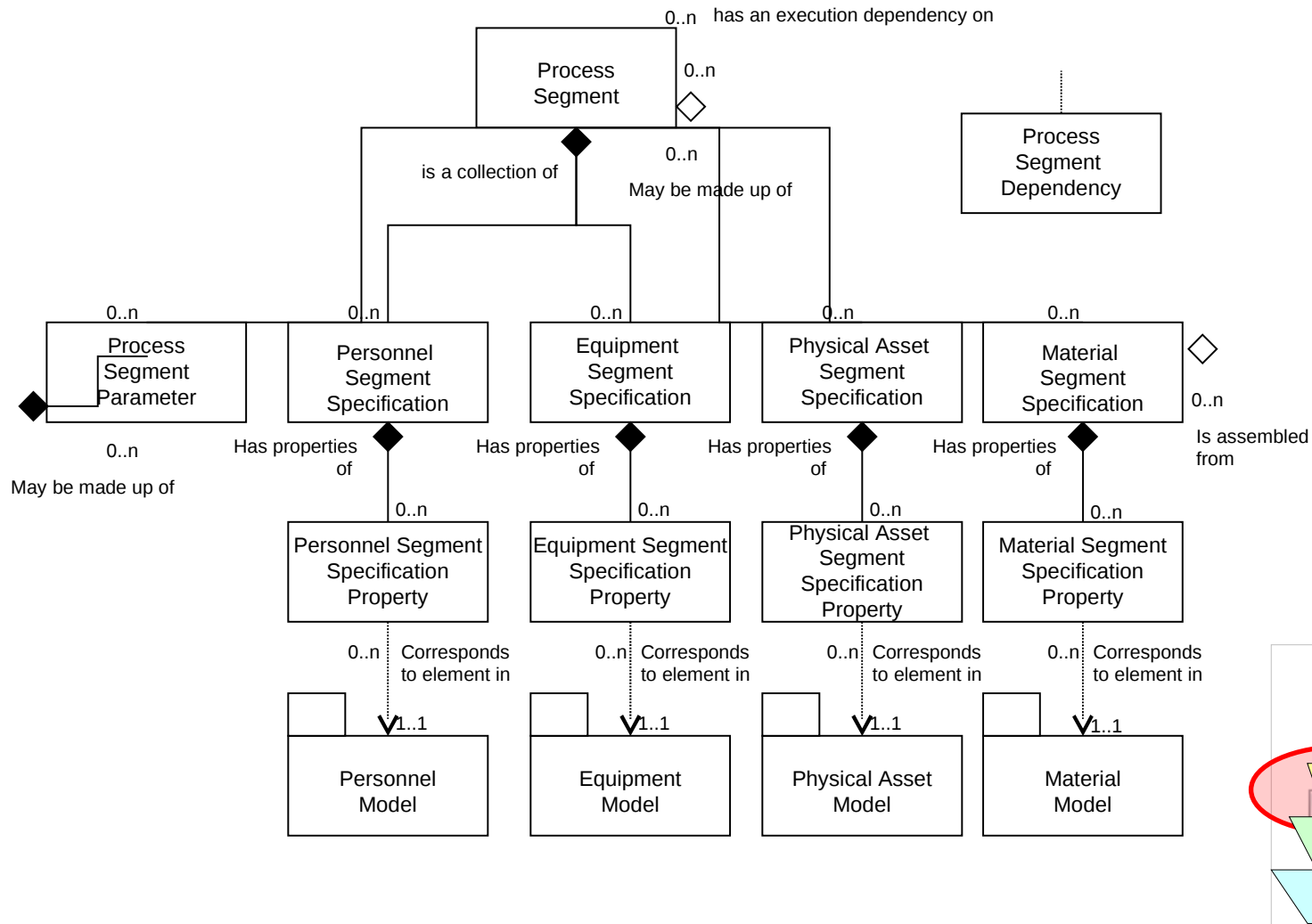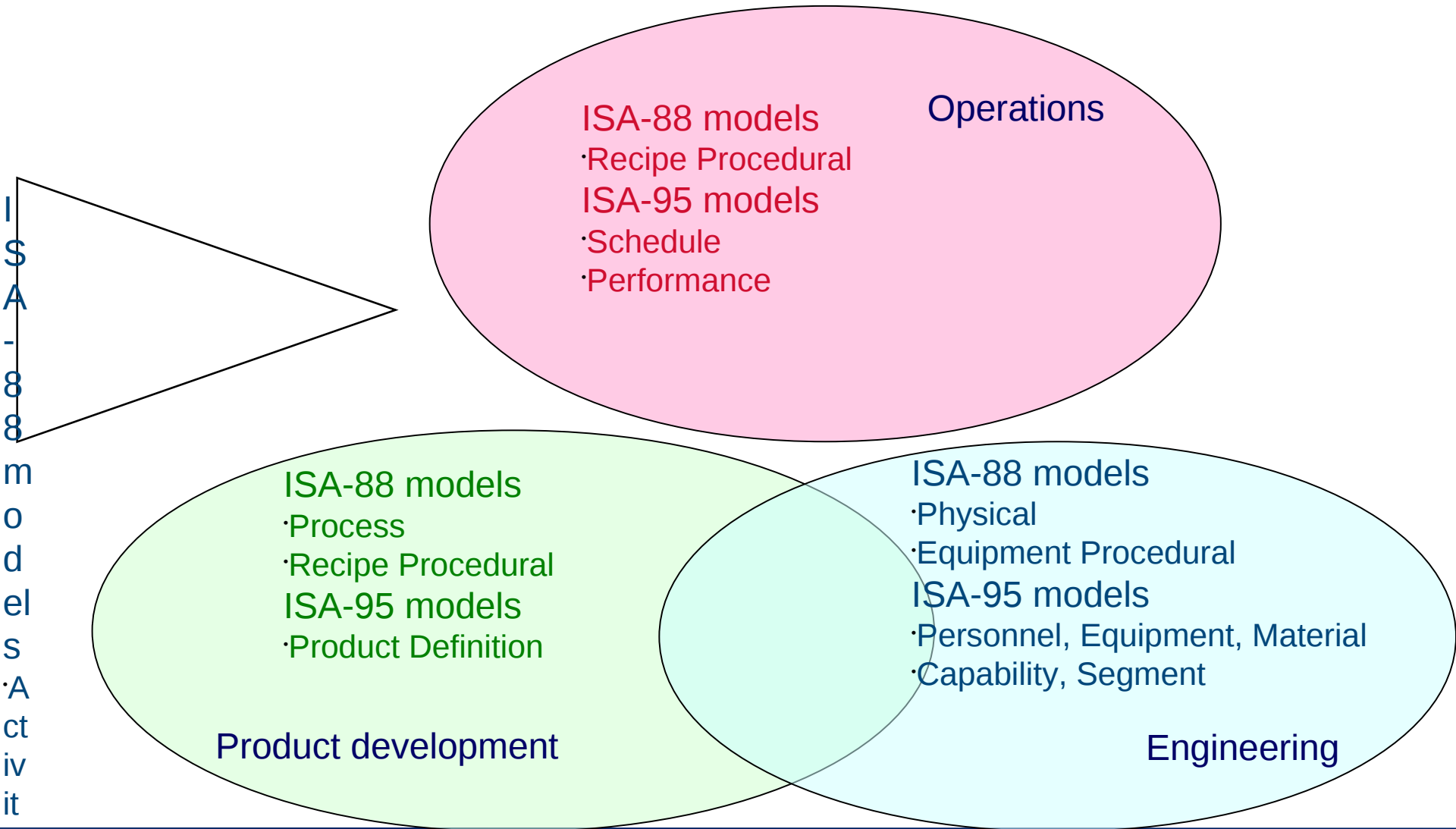
ISA-95 Operational Activity Model
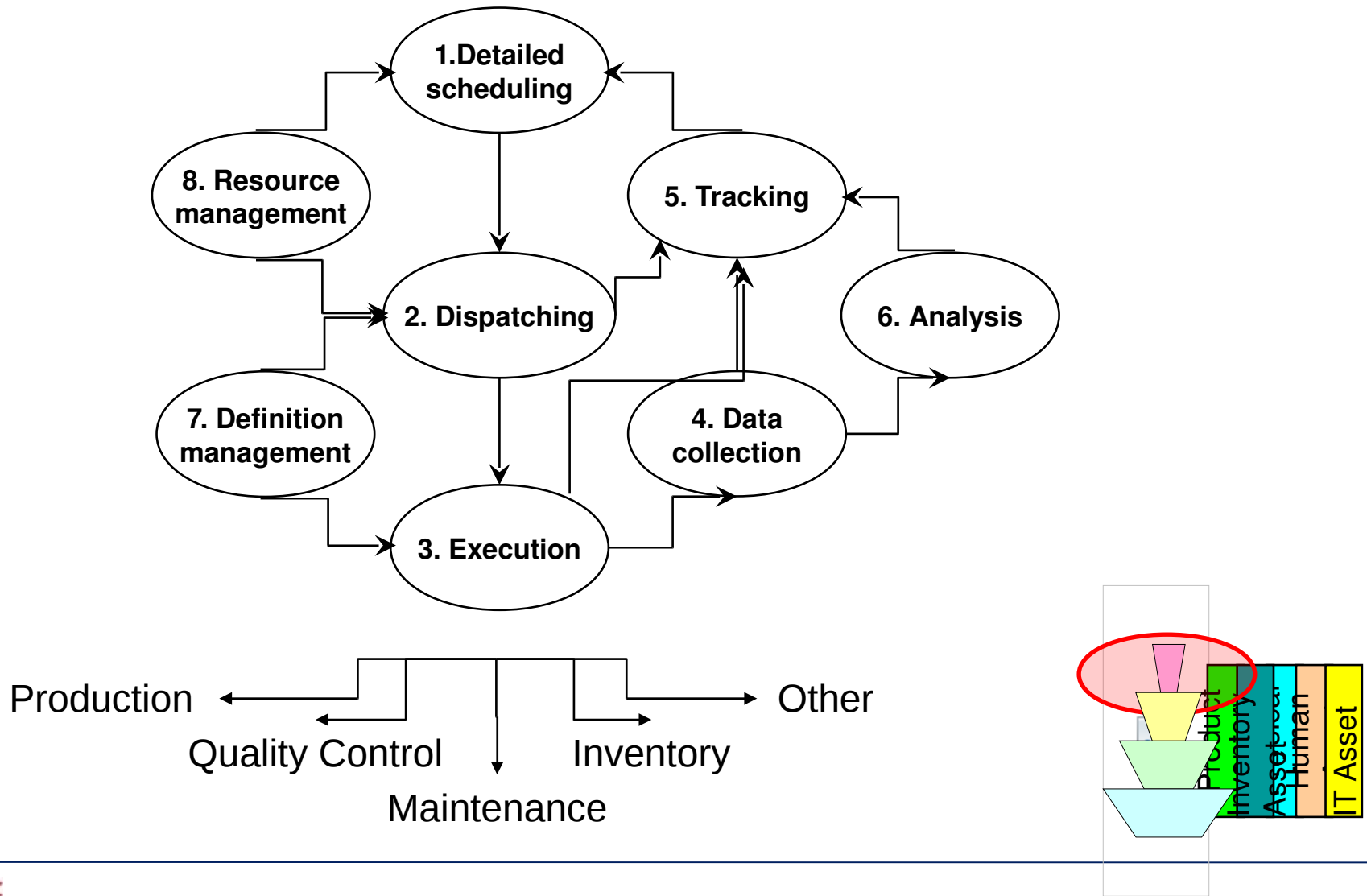
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Production system Lifecycles

ISA-88 & ISA-95 models in Production Lifecycles

ISA-88 models Activity IS

Operations

ISA-88 models
·Recipe Procedural
ISA-95 models
·Schedule
·Performance

ISA-88 models
·Process
·Recipe Procedural
ISA-95 models
·Product Definition

Product development

ISA-88 models
·Physical
·Equipment Procedural
ISA-95 models
·Personnel, Equipment, Material
·Capability, Segment

Engineering

ISA-88 & ISA-95 Objects in Production Lifecycles

Schedule

3. Operations

Requests / Recipes

Segments / RPE

Product Definition

Segments PE/RPE

Segments EPE

Capability

1. Product Dévelopment

Resources Personnel / Equipment / Material

2. Engineering

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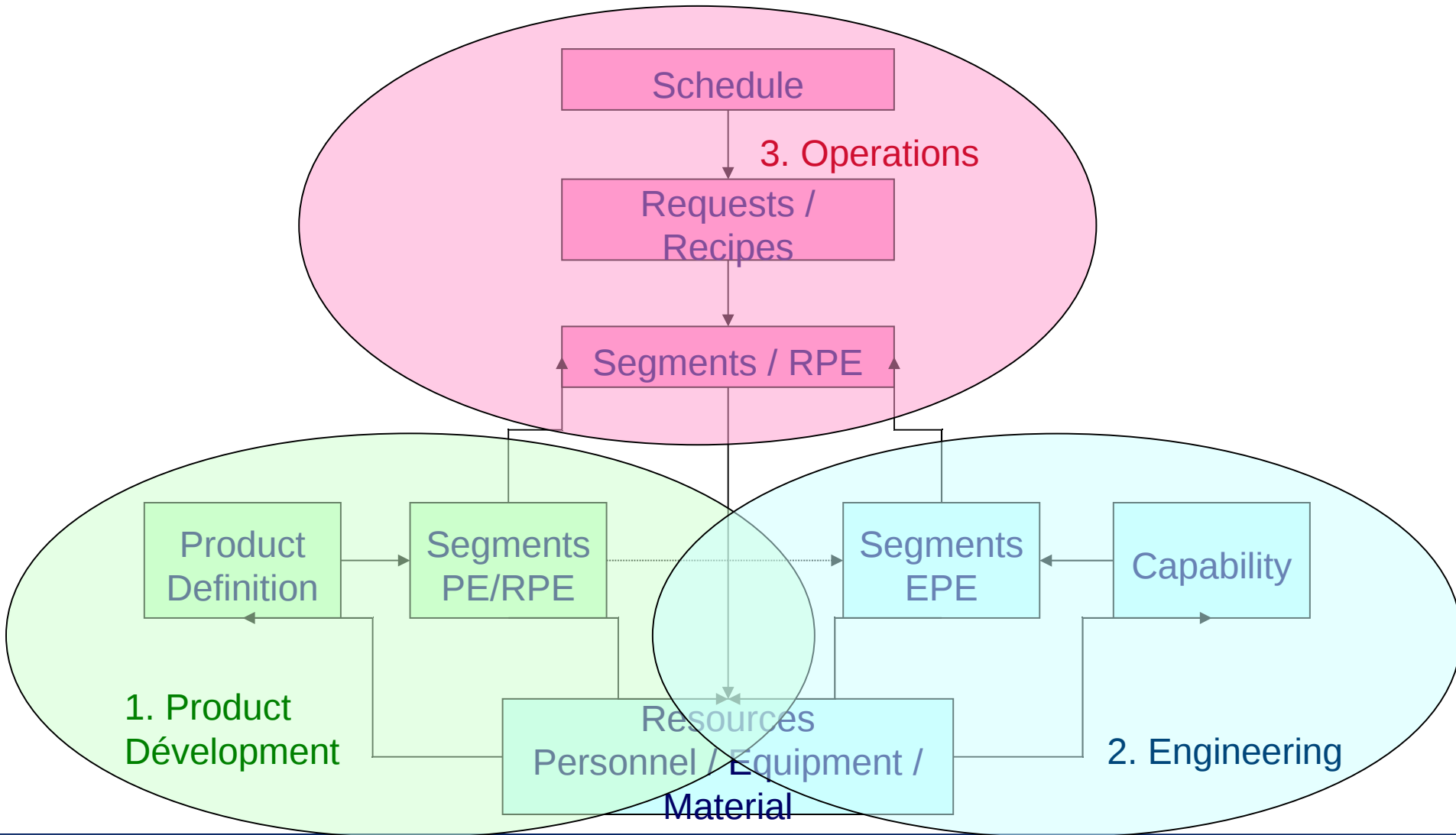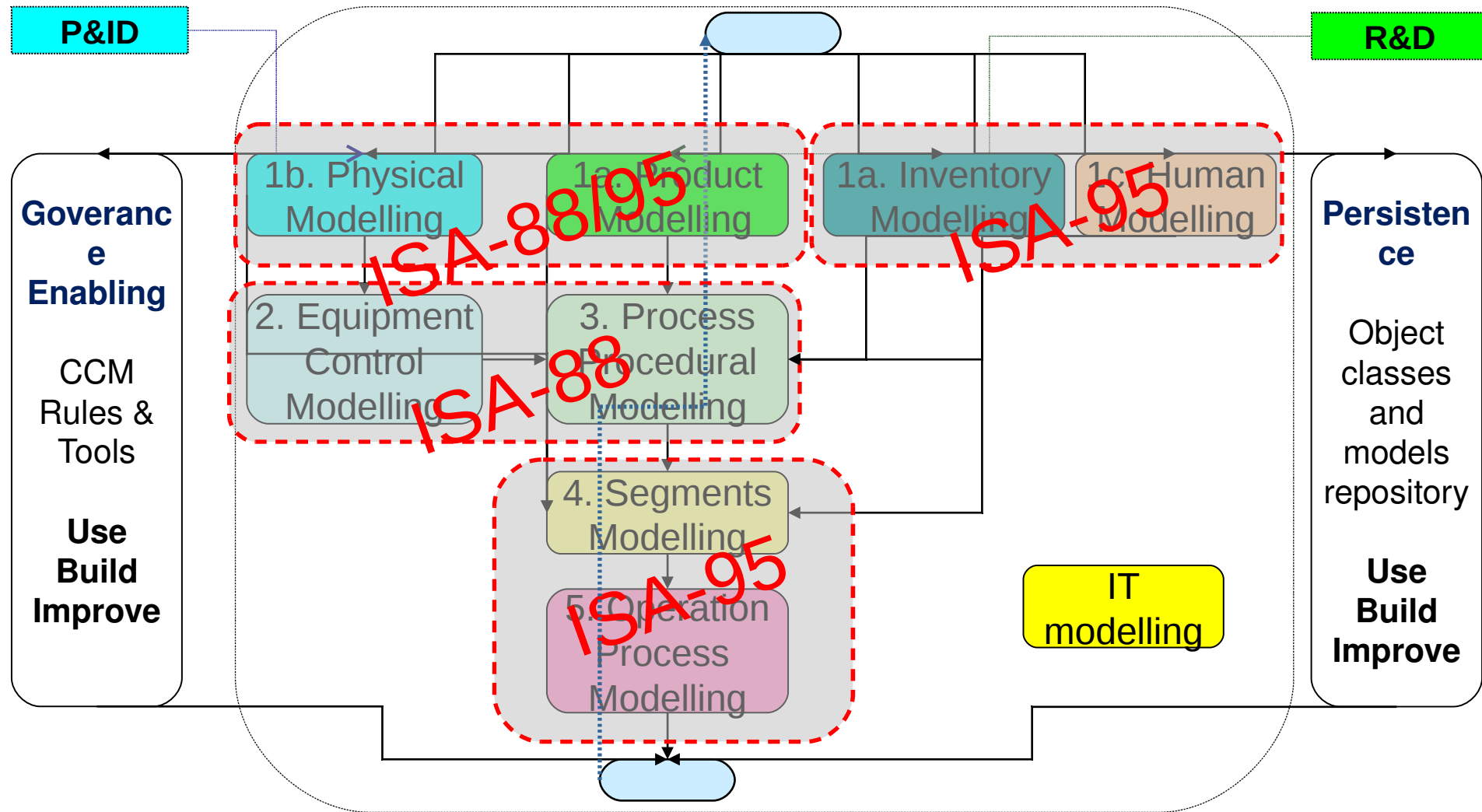- **ISA-88/95 in Production Lifecycles**
- **Methodology**

IAM framework definition overview (see IAP)

P&ID

R&D

1b. Physical Modelling

1a. Product Modelling

1a. Inventory Modelling

1c. Human Modelling

CCM Rules & Tools

Use Build Improve

2. Equipment Control Modelling

3. Process Procedural Modelling

Object classes and models repository

Use Build Improve

4. Segments Modelling

5. Operation Process Modelling

IT modelling
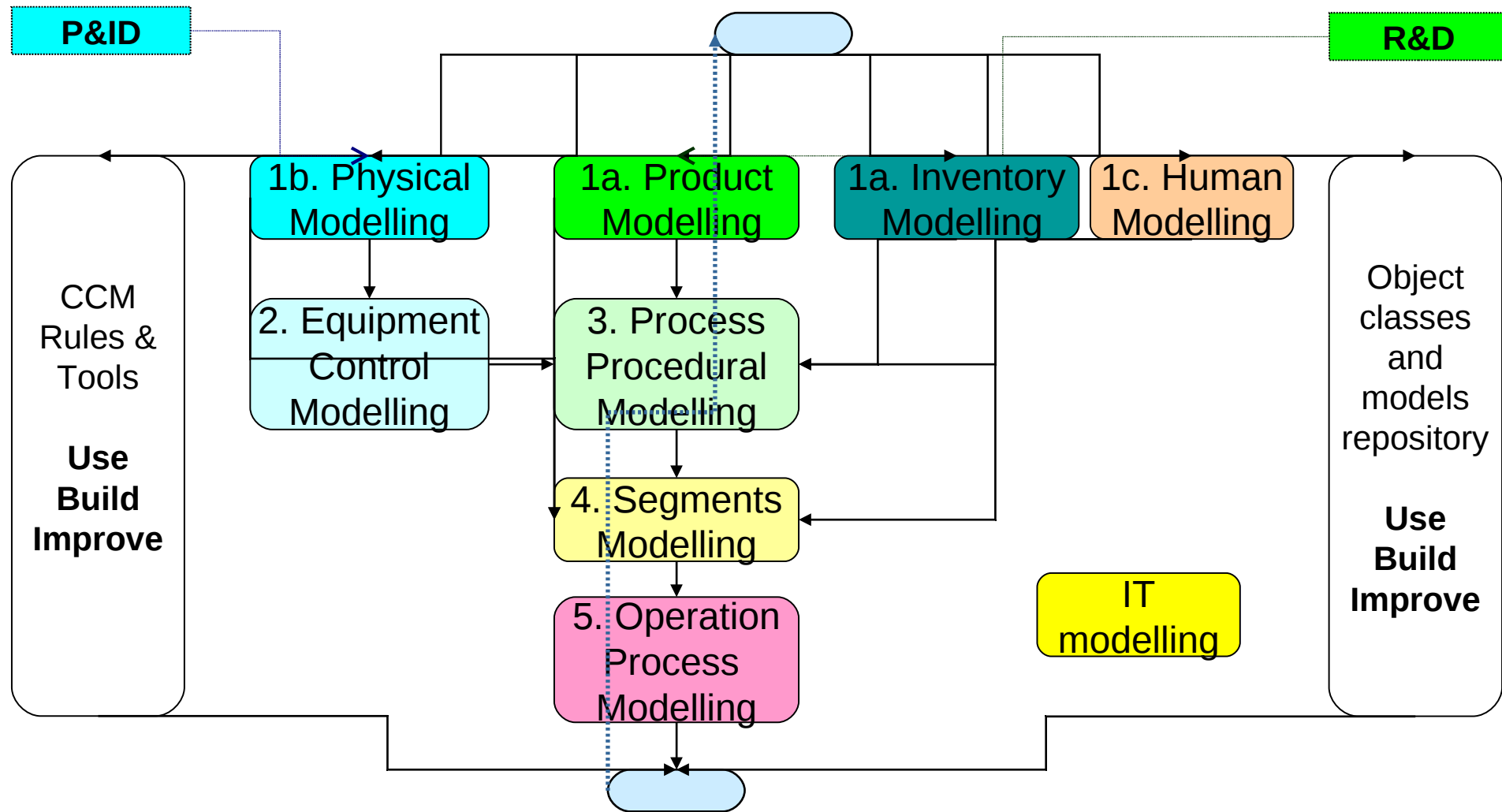
Ongoing Industrial Architecture

Interactions Hierarchy

Business

Exécution

(ISA-95, MES)

(ISA-88, Equipment Control)

Business Processes

Business Activities

Operation Processes

Operation Activities

Operating Instructions Procedural Elements

Physical Processes
Recipes, routing
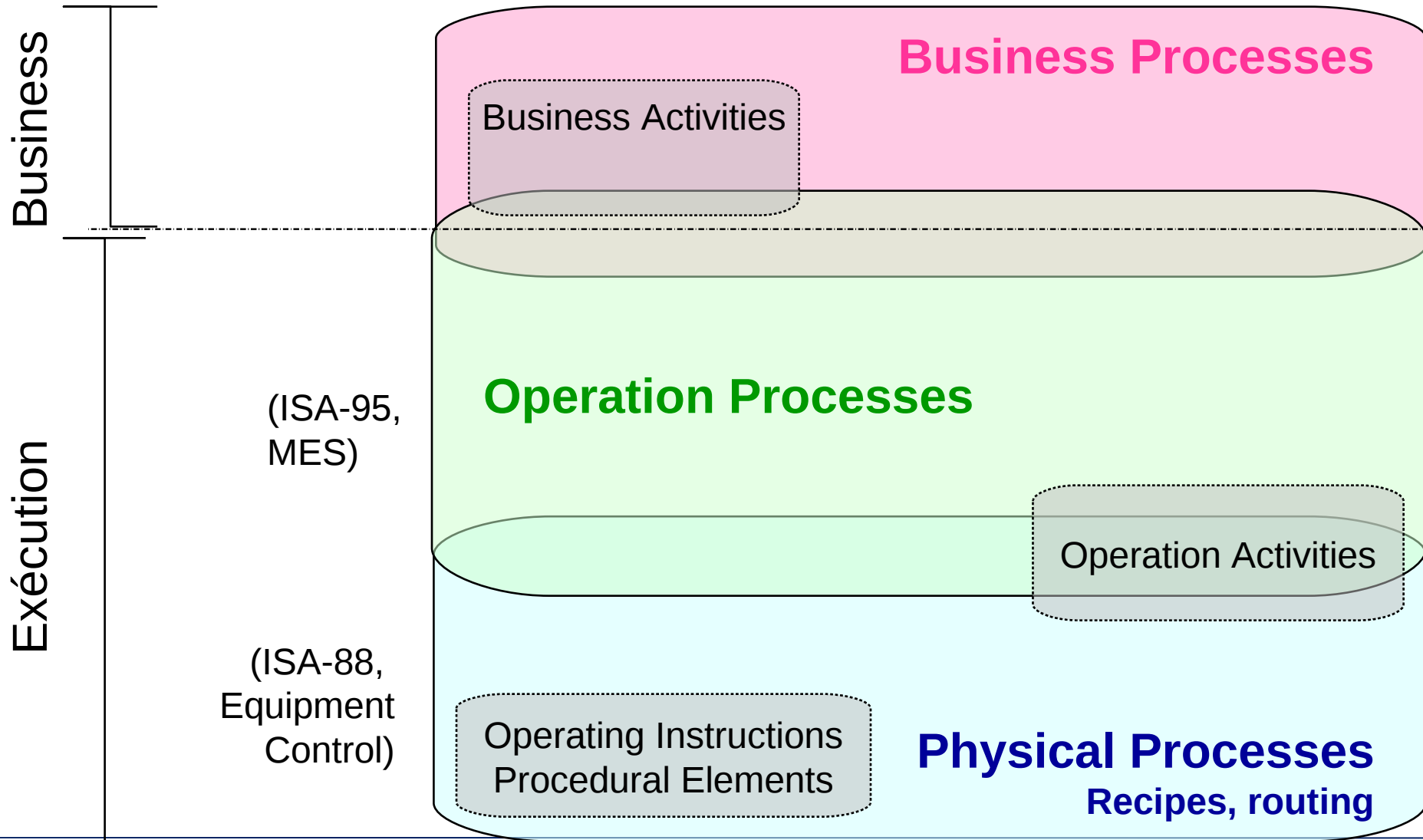
Examples of Description standards

Business / Operation process Description:
BPMN, OSSAD, UML

Schedule

Requests / Recipes

Product Definition: PPC

Physical Process Description : PFC

Segments / RPE

Product Definition

Segments PE/RPE

Segments EPE

Capability

Resources Personnel / Equipment / Material
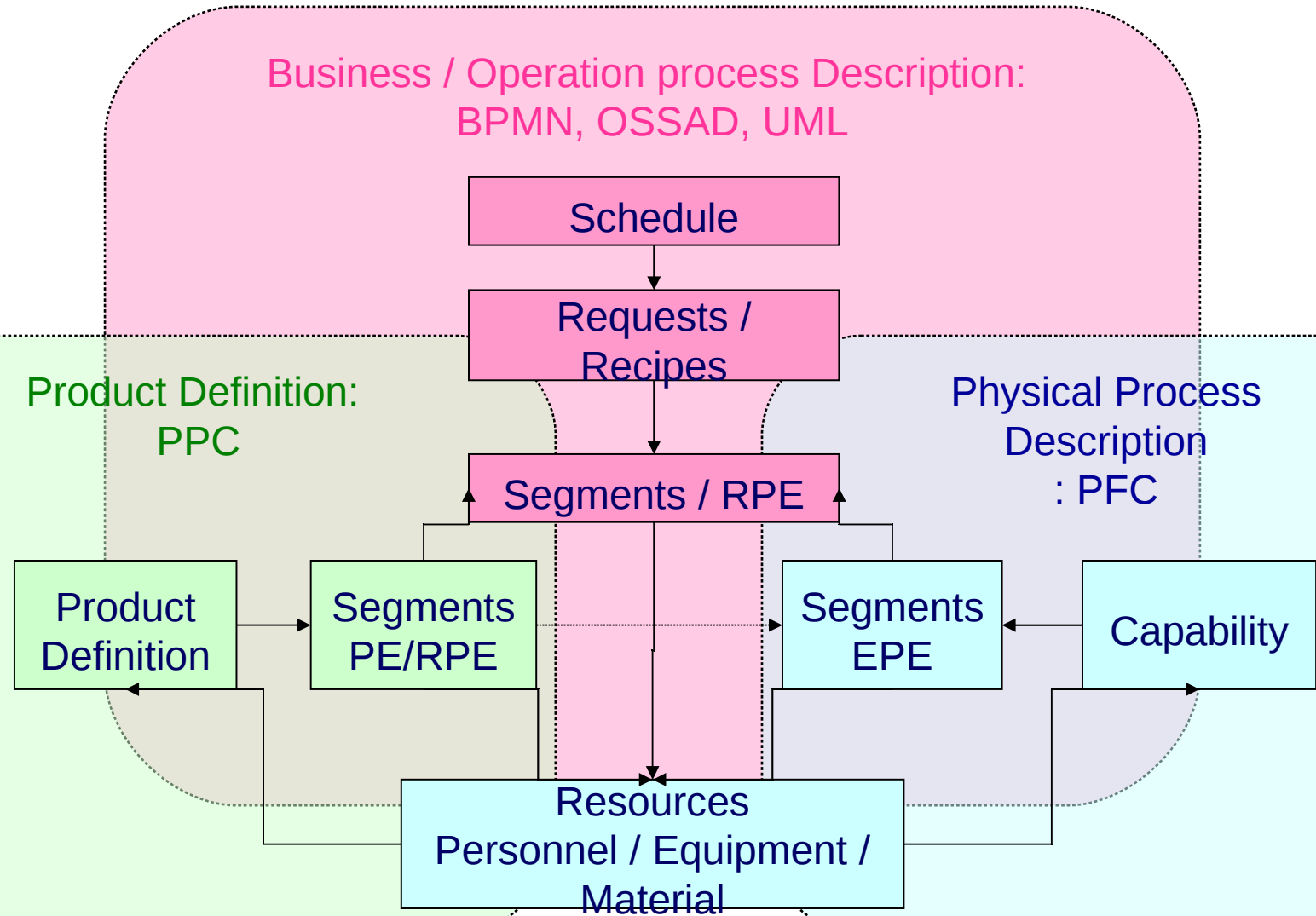
Modular ISA-88/95 structure

Entreprise,
Site, Area,
Work Center,
Work Unit

Physical
Breakdown

Production,
Quality,
Inventory,
Maintenance

Domains

Object Classes
(Templates)

Decisional
Level

Functionnal
Objects

Business
Processes,
Operation
Processes
Physical Processes
Equipment control

Exclusive
States

Run, Stop,
Hold…
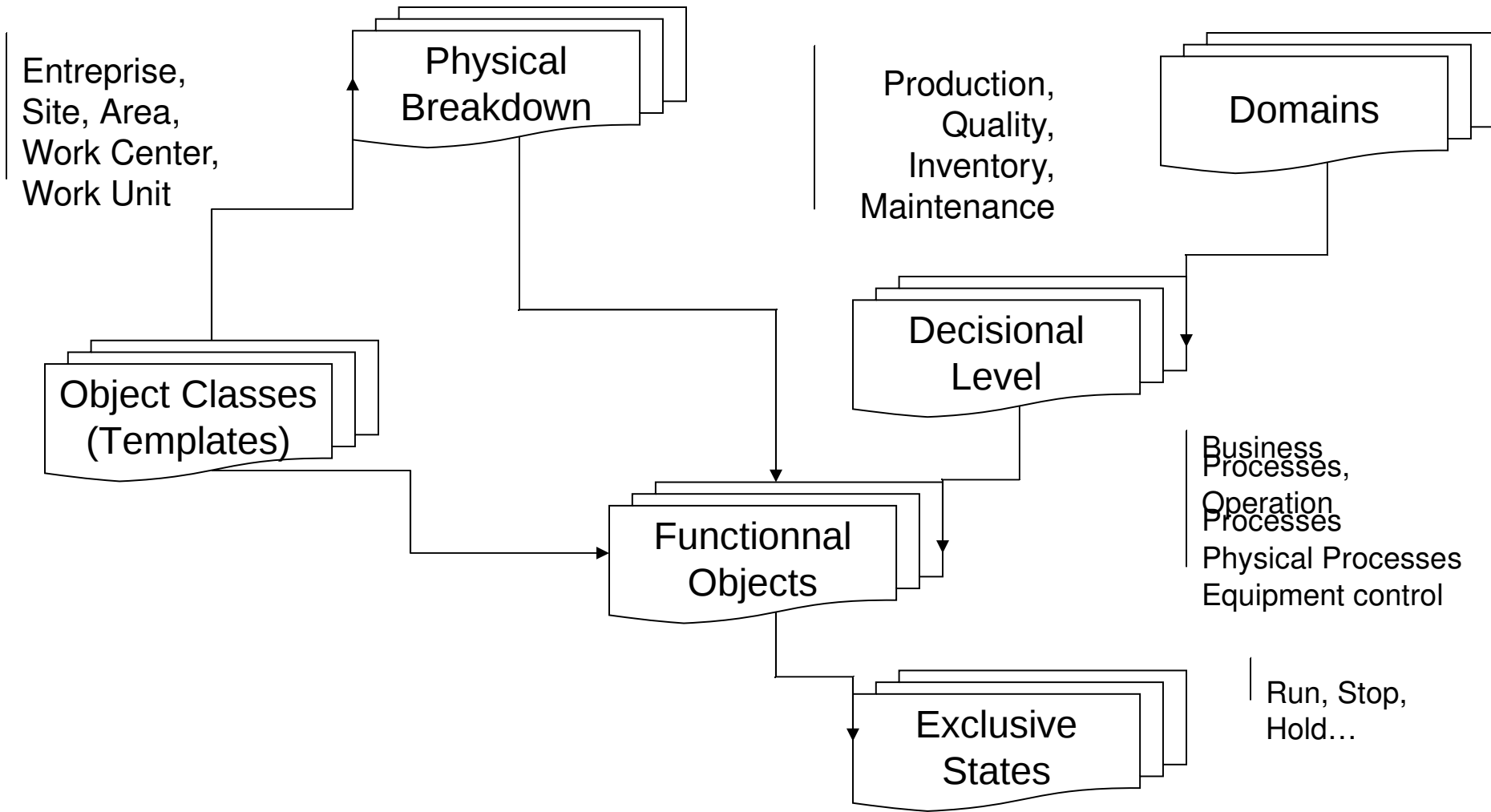
Information Elements

Domain	Model	Std	Information elements
Product Asset	Process Product	ISA-88 ISA-95	Product Hierarchy Product Definition
Inventory Asset	Material	ISA-95	Material Resources
Equipment Asset	Physical Equipment Physical Asset	ISA-88 ISA-95	Equipment Hierarchy Equipment Resources
Human Asset	Personnel	- ISA-95	Personnel Hierarchy Personnel Resources
Equipment Control	Procedural	ISA-88	Functional Hierarchy Equipment Procedural Elements
Physical Process Control	Procedural	ISA-88	Physical Processes / Procedural Elements Physical Process Transform Components
Physical Process Mngt	Segment	ISA-95	Segments
Operation Process Mngt	Operation Activity	ISA-95	Operation Processes Activities / Tasks

Thank You !