Practical Enterprise Modelling: ISA 88 and ISA 95 standards

IEC SB3 Sponsored Seminar
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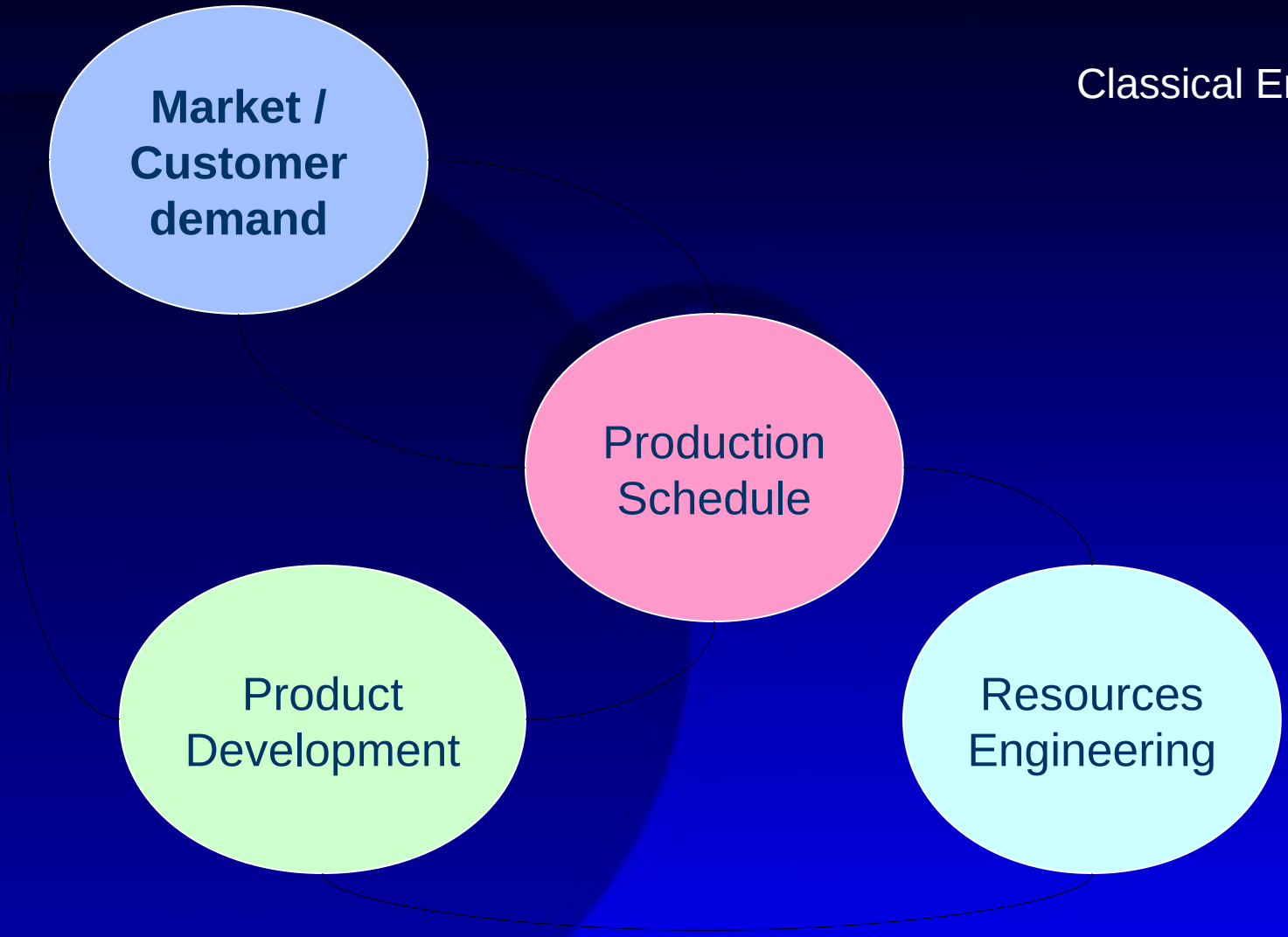
Agenda

- ISA 88 and 95 in SCM and Production Scheduling
- ISA 95 : Enterprise-Production Communication
- ISA 88 : Modular Control

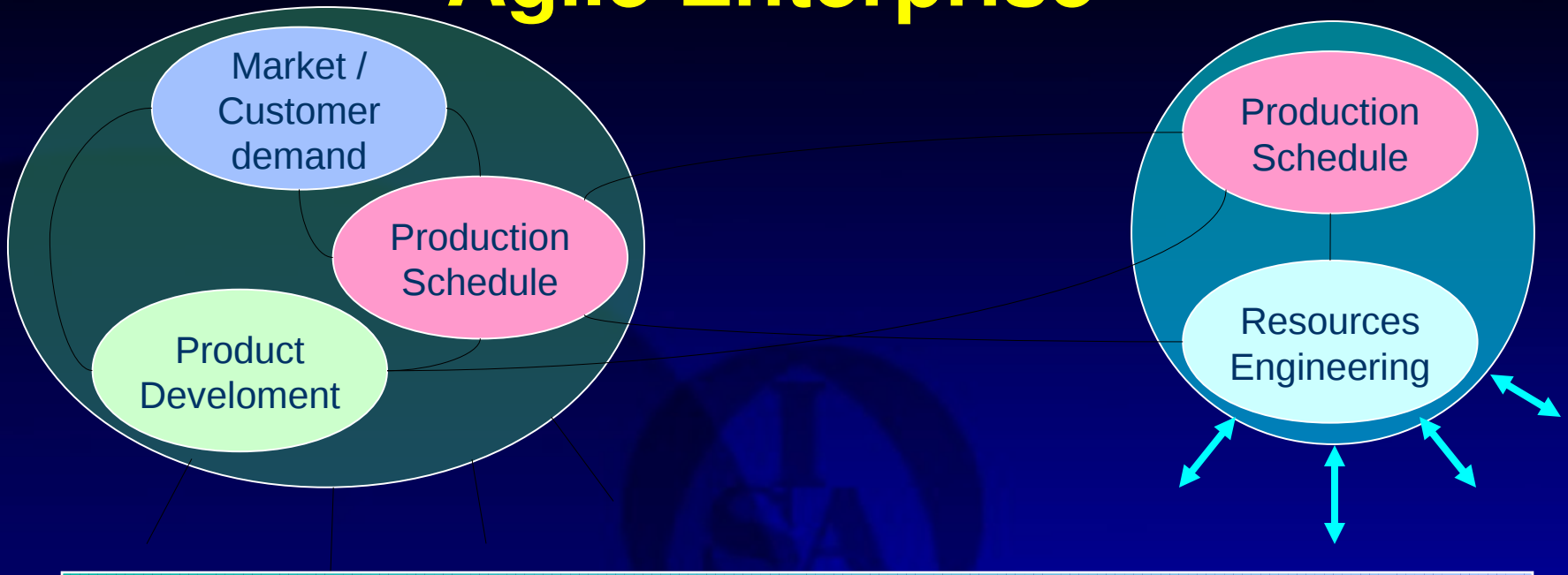
ISA 88 and 95 in SCM and Production Scheduling

Market / Customer driven production

Classical Enterprise



Agile Enterprise



Enterprise System 1

Manufacturing Control System 1

Manufacturing Control System 2

Company 1 with manufacturing

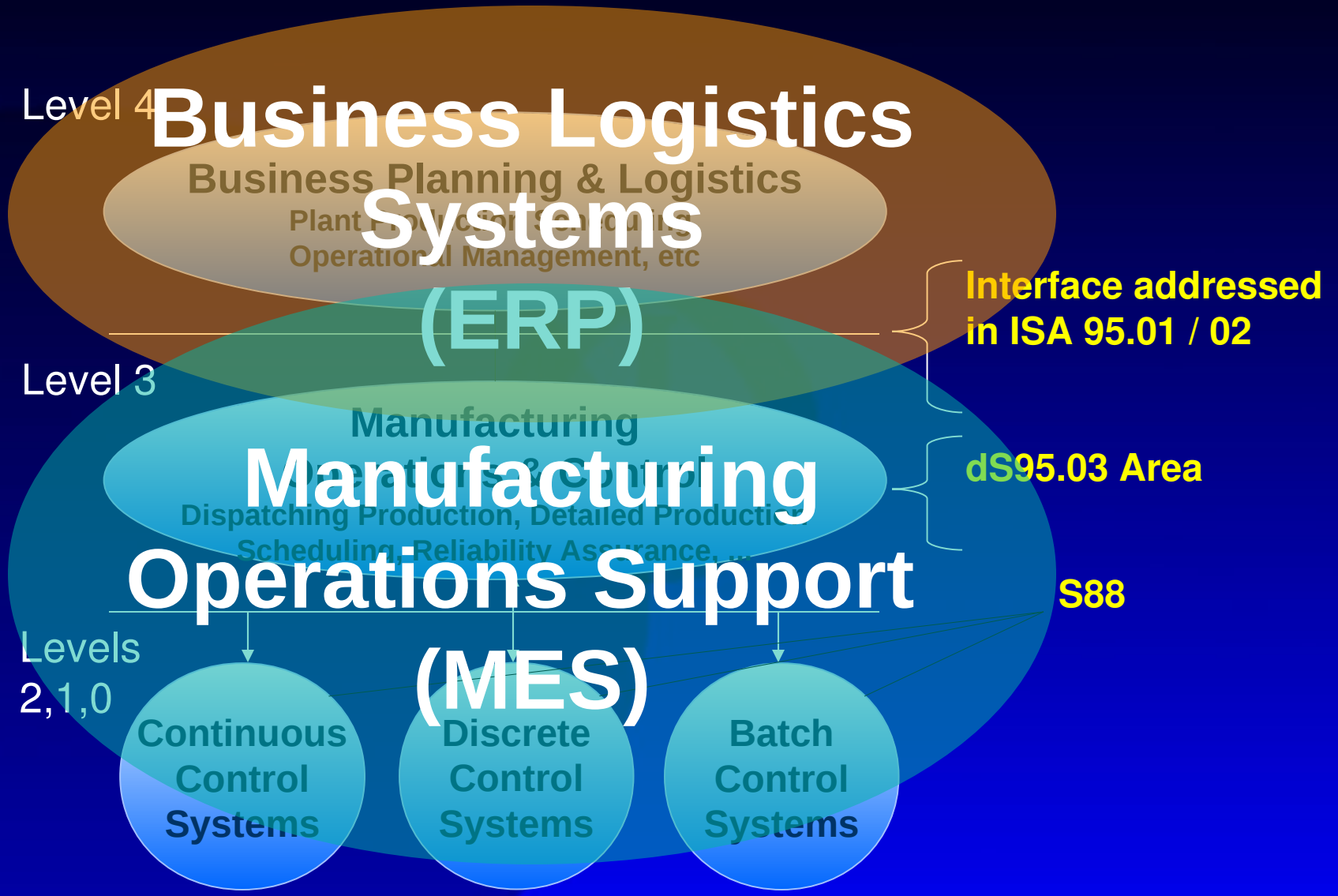
Enterprise System 2

Company 2 with No manufacturing

Manufacturing Control System 3

Company 3 Contract manufacturer

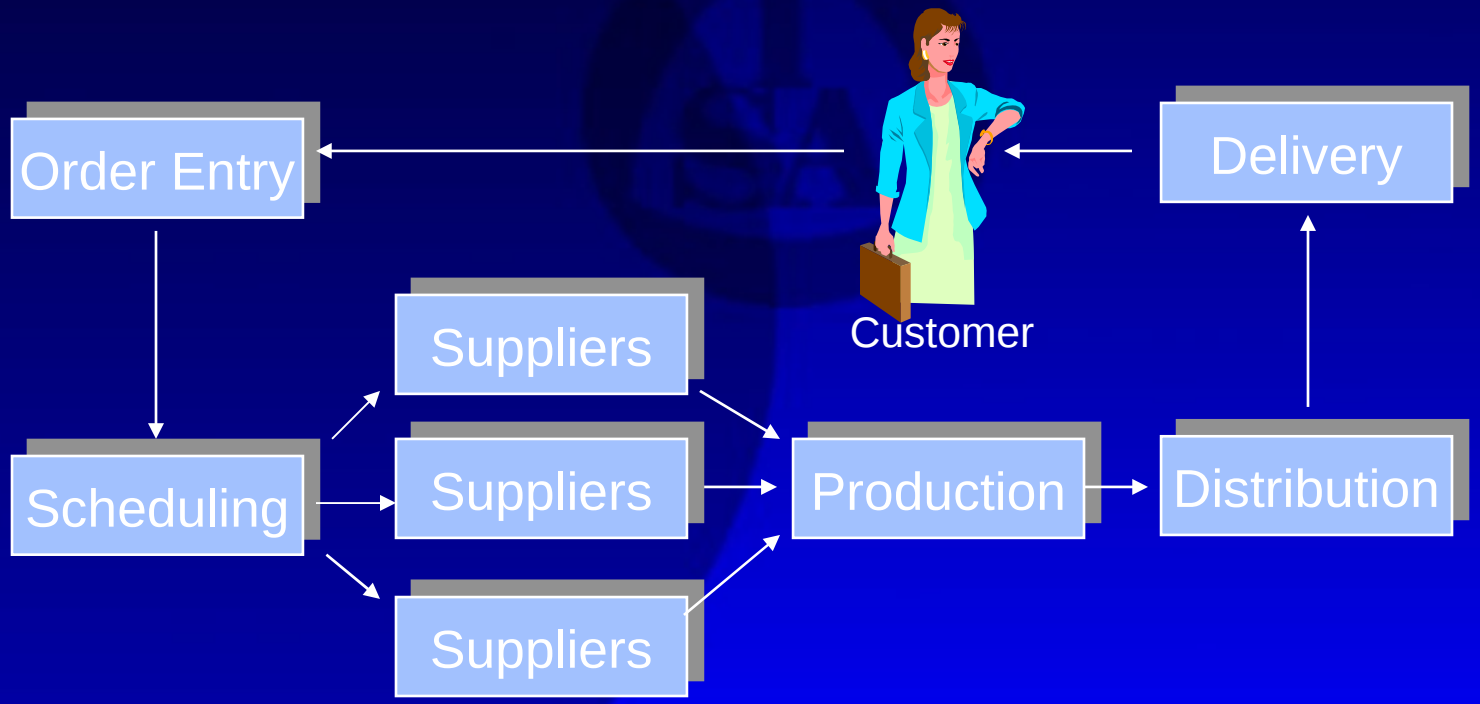
S95.01 Scope



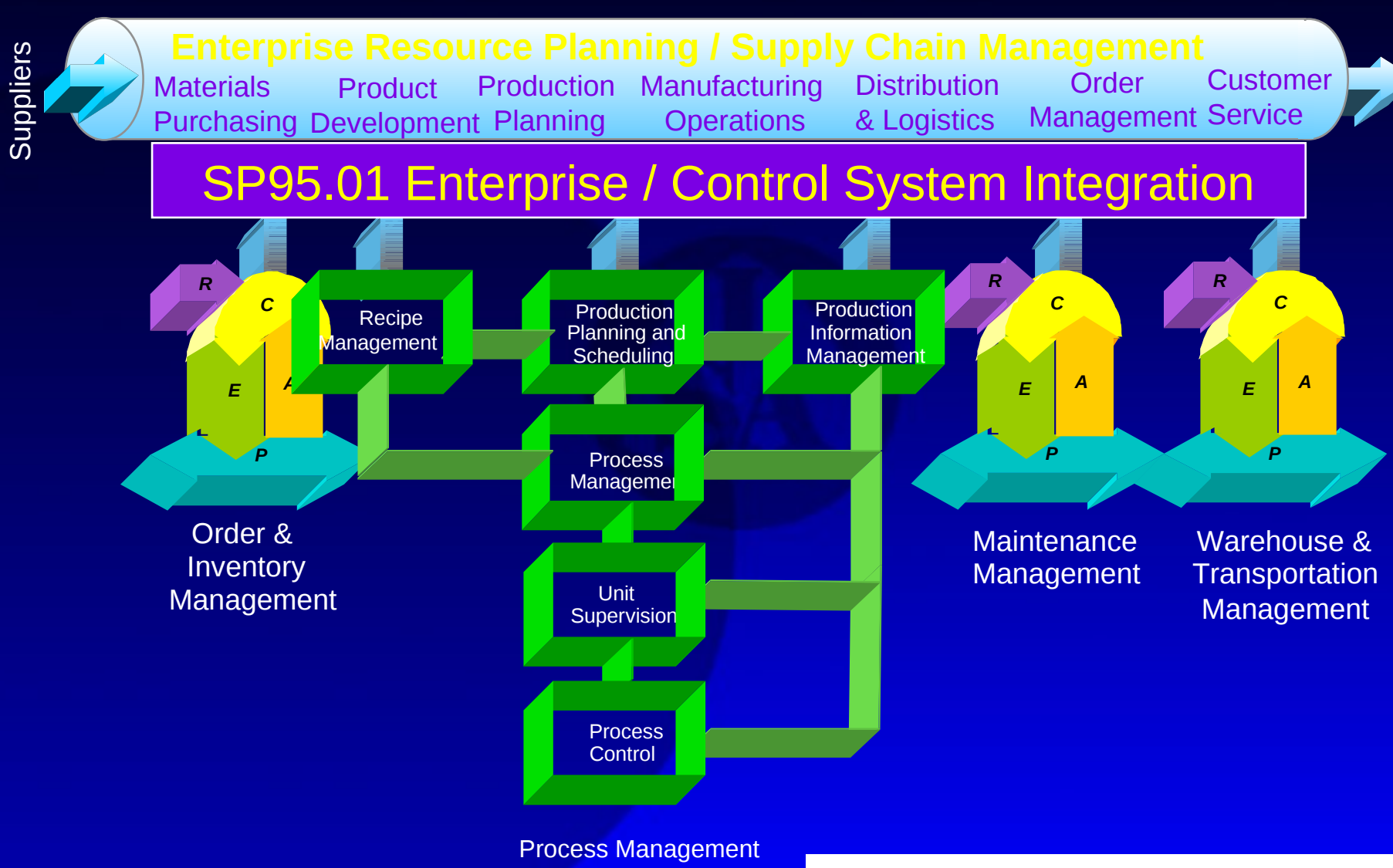
Source: ISA dS95.01 Enterprise/Contr

Manufacturing in The Supply Chain

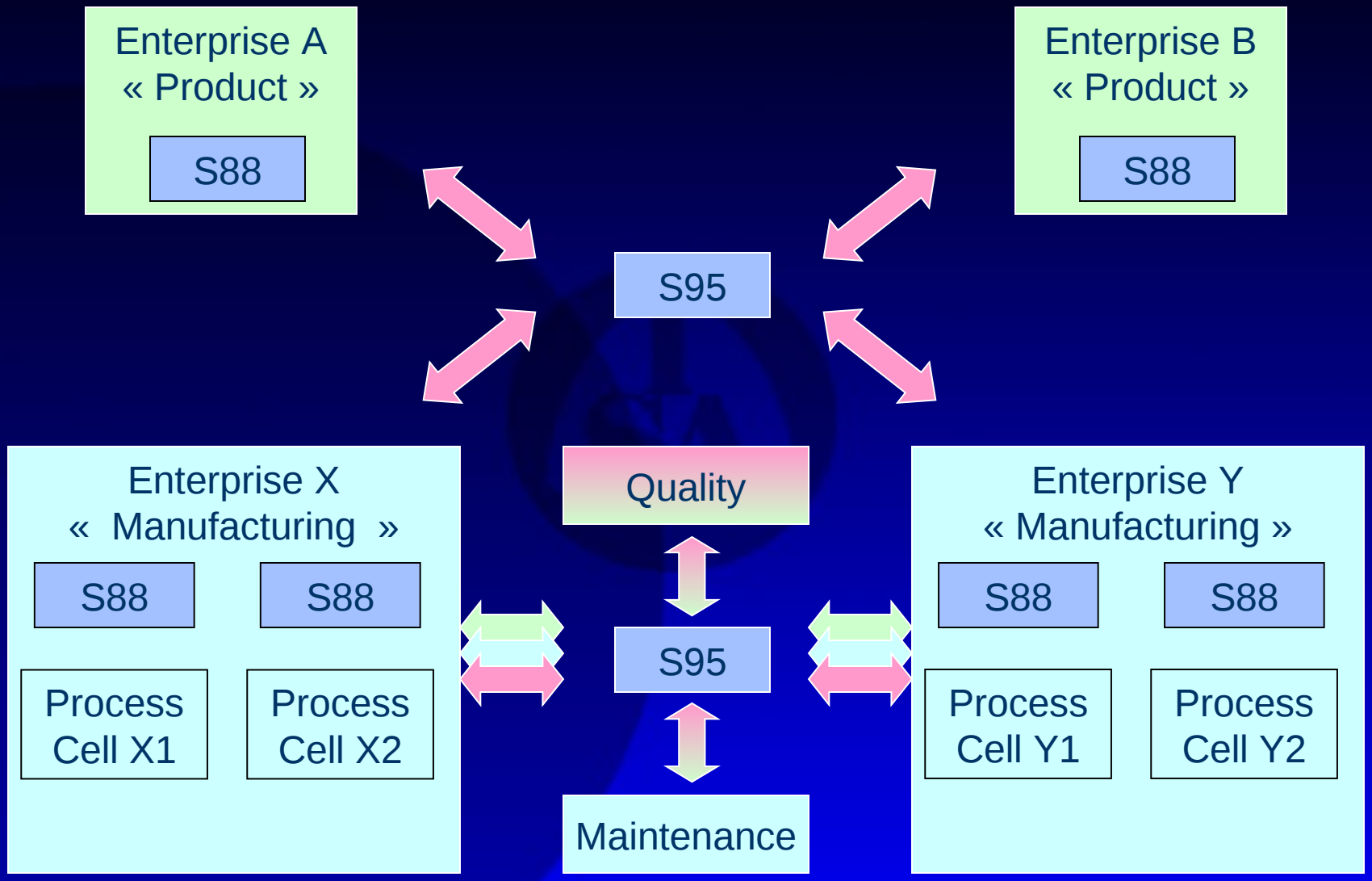
- The Supply Chain
  - The network of activities in a company that take place from customer order to customer delivery



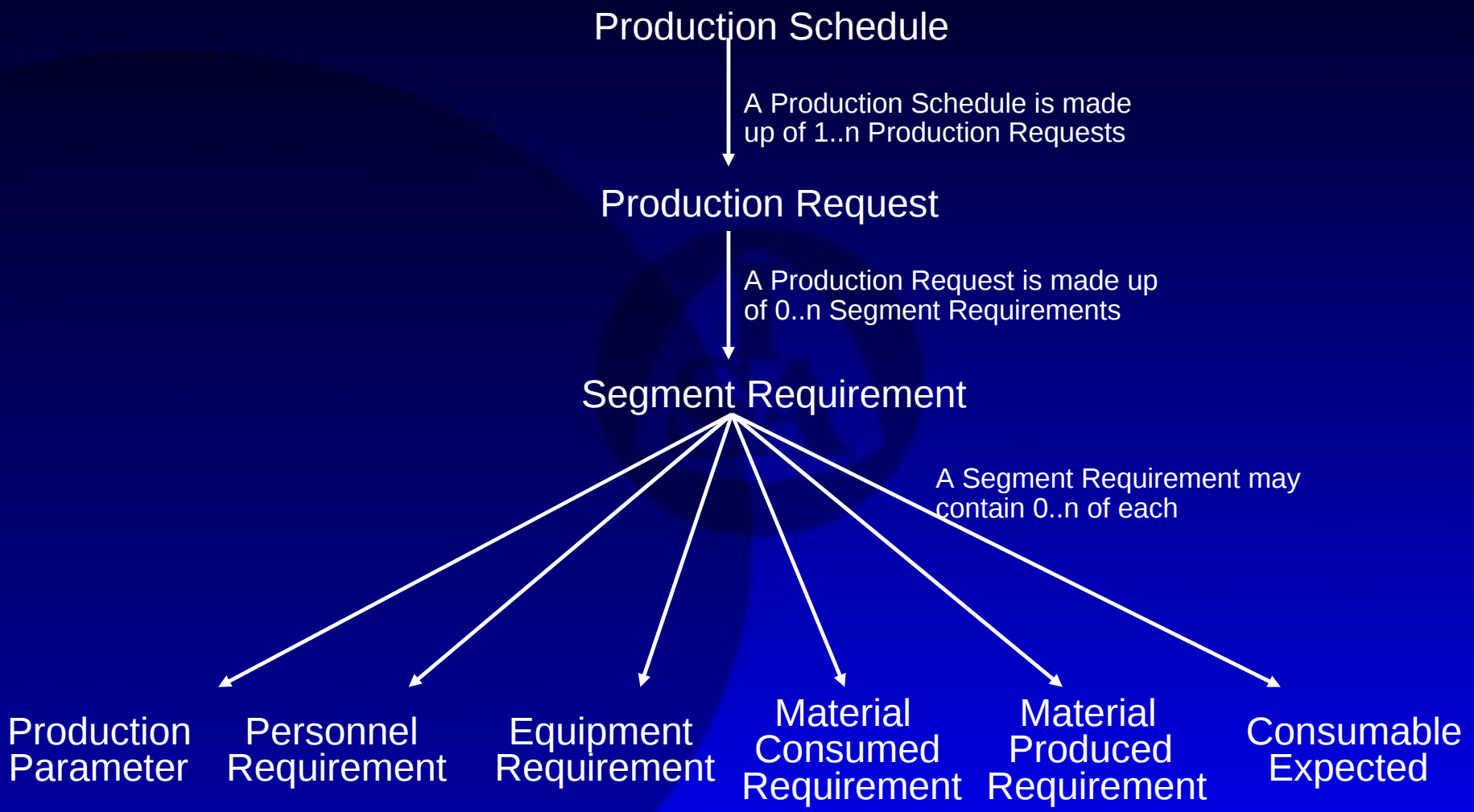
S95/S88 and The Supply Chain



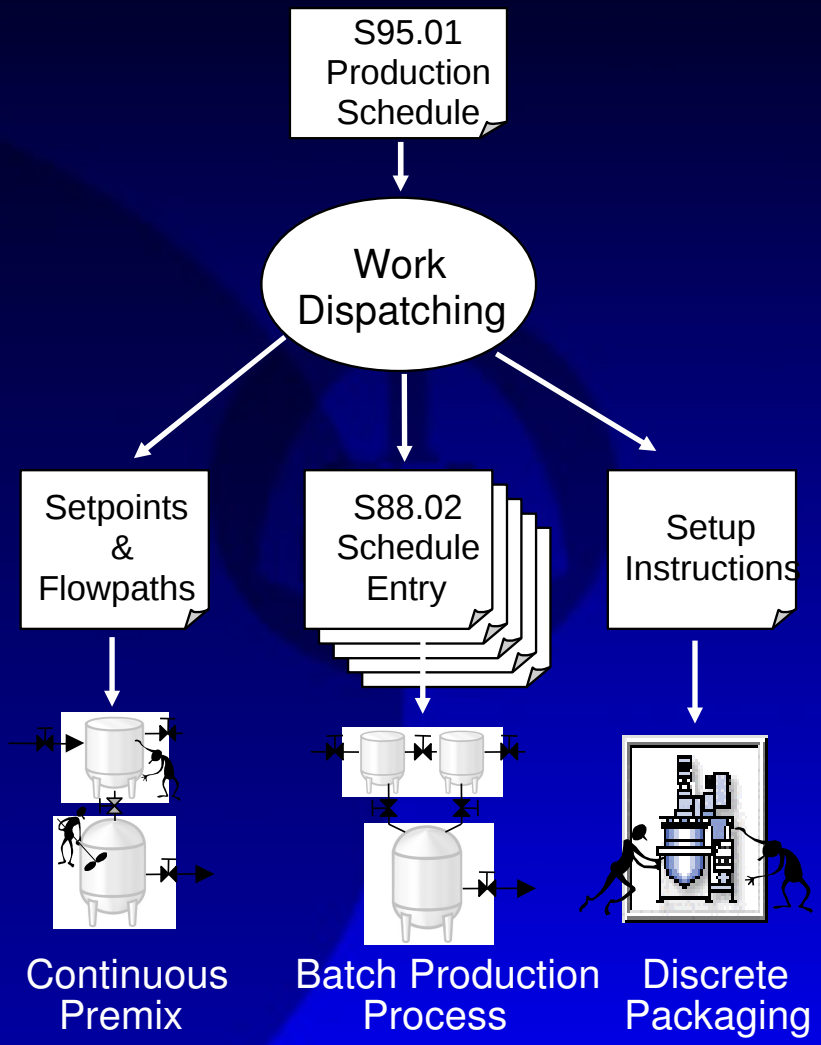
S88 et S95


Enterprise A
« Product »
S88
Enterprise B
« Product »
S88
S95
Quality
Enterprise X
« Manufacturing »
S88
S88
Process
Cell X1
Process
Cell X2
S95
Maintenance
Enterprise Y
« Manufacturing »
S88
S88
Process
Cell Y1
Process
Cell Y2

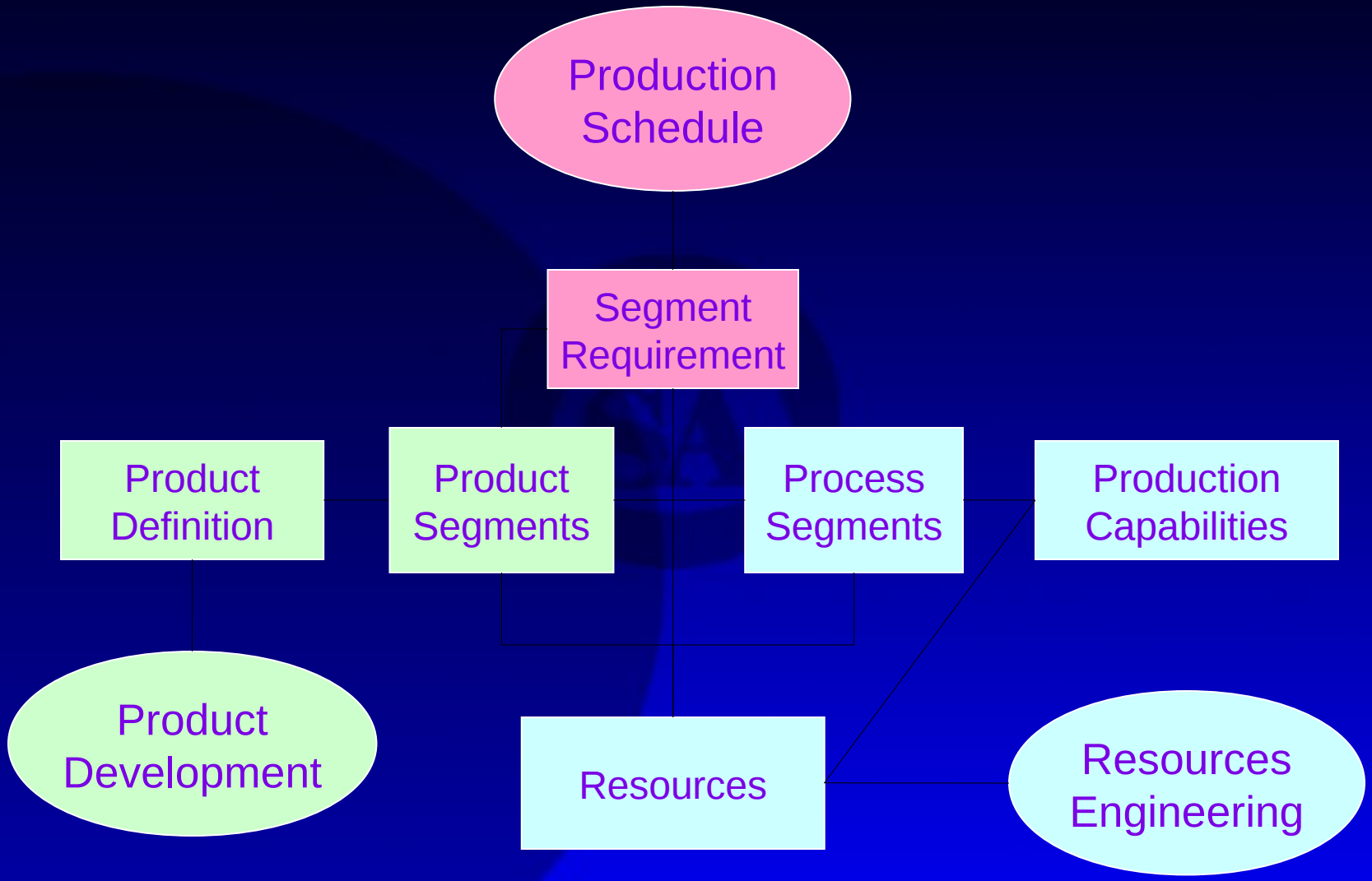
S95.01 Production Schedule Structure



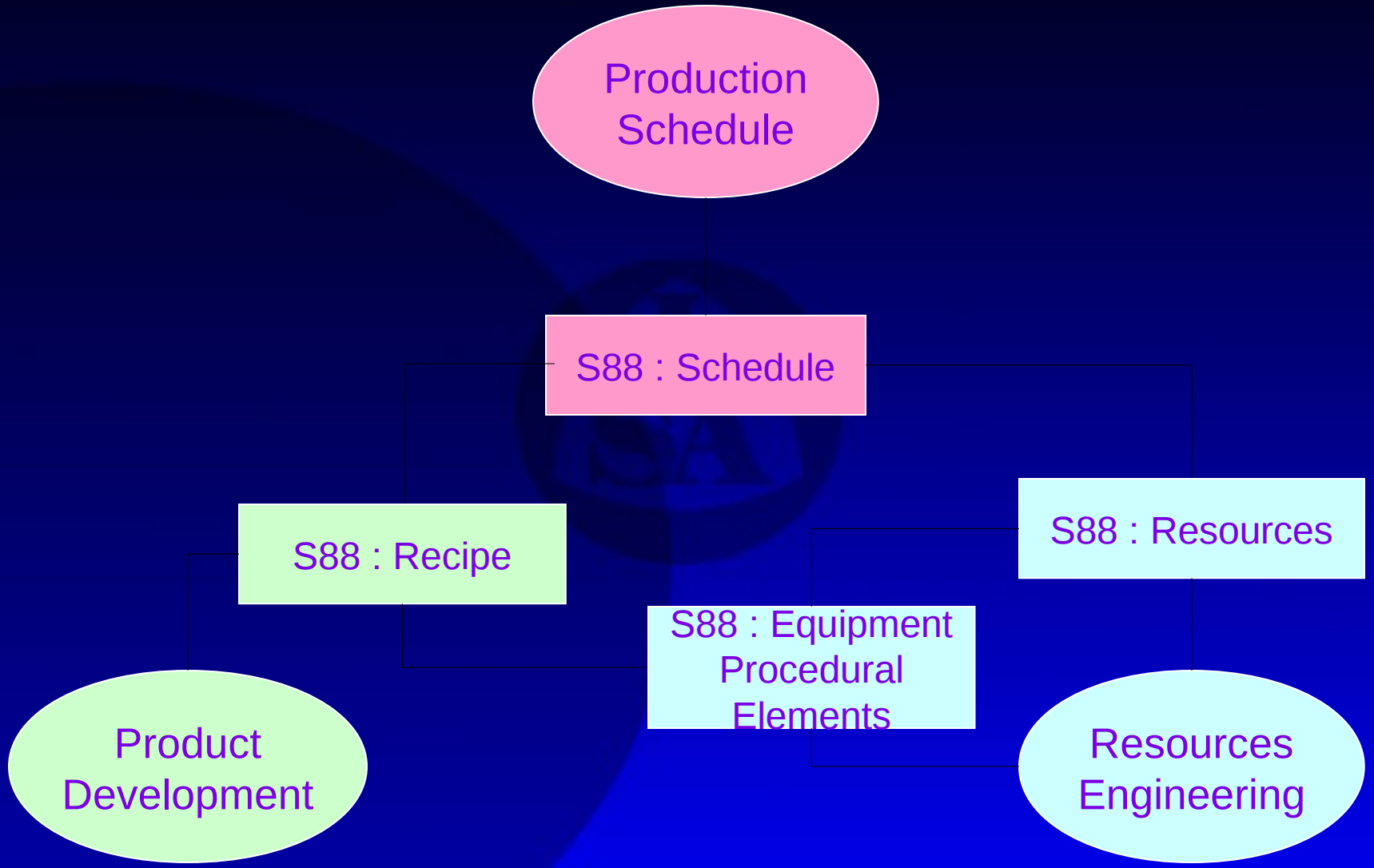
Mixed Format Schedule Application



S95 in Production System Lifecycles



S88 in Production System Lifecycles



ISA 95 : Enterprise – Production Communication

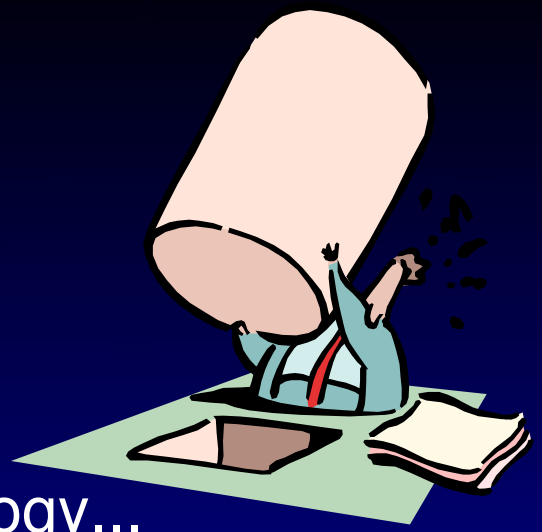
What is ISA95 ? Status

- SP95 committee started in October 1996
- ANSI/ISA95.00.01 available from ISA
  - Submitted to IEC/ISO
  - Joint Working Group (JWG 15) to be established
- ISA 95.00.02 in draft, out for vote
  - Out for committee ballot and public comment
- ISA 95.00.03 in draft
  - Still under development in the committee
- World Batch Forum
  - Developing XML Schemas for the exchanged information

Some SP95 Committee Members / Supporters

- Users
  - Eli Lilly
  - Dow Corning
  - Rohm & Haas
  - Bayer
  - Merck
  - Procter&Gamble
  - UOP
  - DuPont
  - Ben & Jerry's
  - Sterling
  - IBM
  - Nestle
  - Lyondell Chemical
  - Novo Nordisk
  - Tava Technologies
  - Aurora Biosciences
  - Pharmacia
  - Lubrizol
  - Bechtel
  - EastmanK
  - Genemtech
- Vendors
  - ABB
  - SAP
  - ABB Data
  - Honeywell
  - Marcam Electric
  - GSE System
  - ORSI
  - AspenTech
  - Sequencia
  - Rockwell
  - FRSI
  - OSI
  - HP
  - Siemens
  - InCode
  - Yokogawa
  - InCode
  - Intellution
  - IBM GS
  - BaseTen
  - Wonderware
  - Foxboro
  - Oracle
  - Microsoft
  - Propack
  - Schneider
- General
  - Purdue
  - Fluor Daniels
  - AM

Why Did We Start SP95 ?



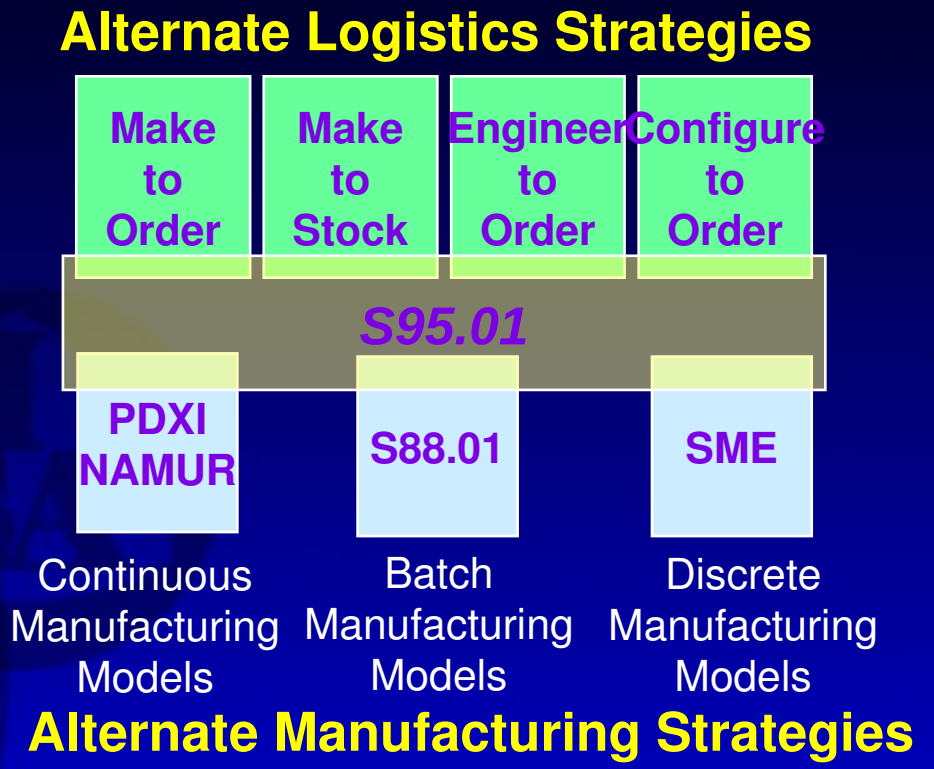
- Integration of business (logistics) systems to manufacturing is hard to do
  - Different systems, cultures, terminology...
  - Many benefits expected from standardization and documentation of “best practices”
- Effective operation of manufacturing is hard to do
  - MES solutions are too related to processing methods and too industry-specific
  - Many benefits expected from standardization and documentation of “best practices”

Business Defines the Need

- There must always be a business need for information to be exchanged
- Requirements for exchanged information are always driven by business needs & business processes
- Typical Business Drivers:
  - Available To Promise
  - Reduced Cycle Time
  - Supply Chain Optimization
  - Asset Efficiency
  - Agile Manufacturing

How Does S95* Help?

- Separate the business processes from the manufacturing processes
  - Allow changes in production processes without requiring unnecessary changes scheduling and logistics processes
- Provide a clear demarcation of responsibilities and functions
- Provide a clear description of

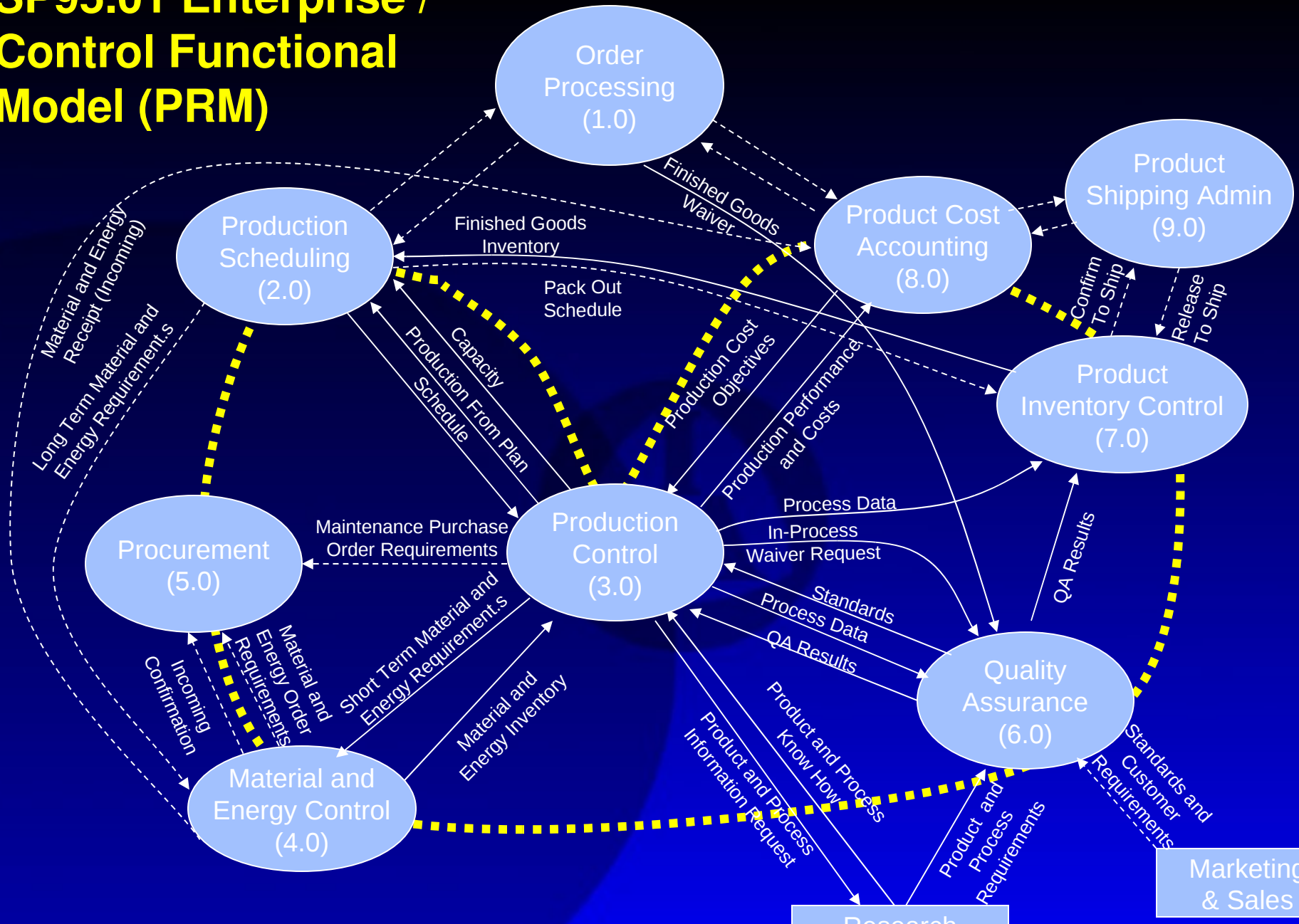


* S95 is used as a short form for ANSI/ISA95

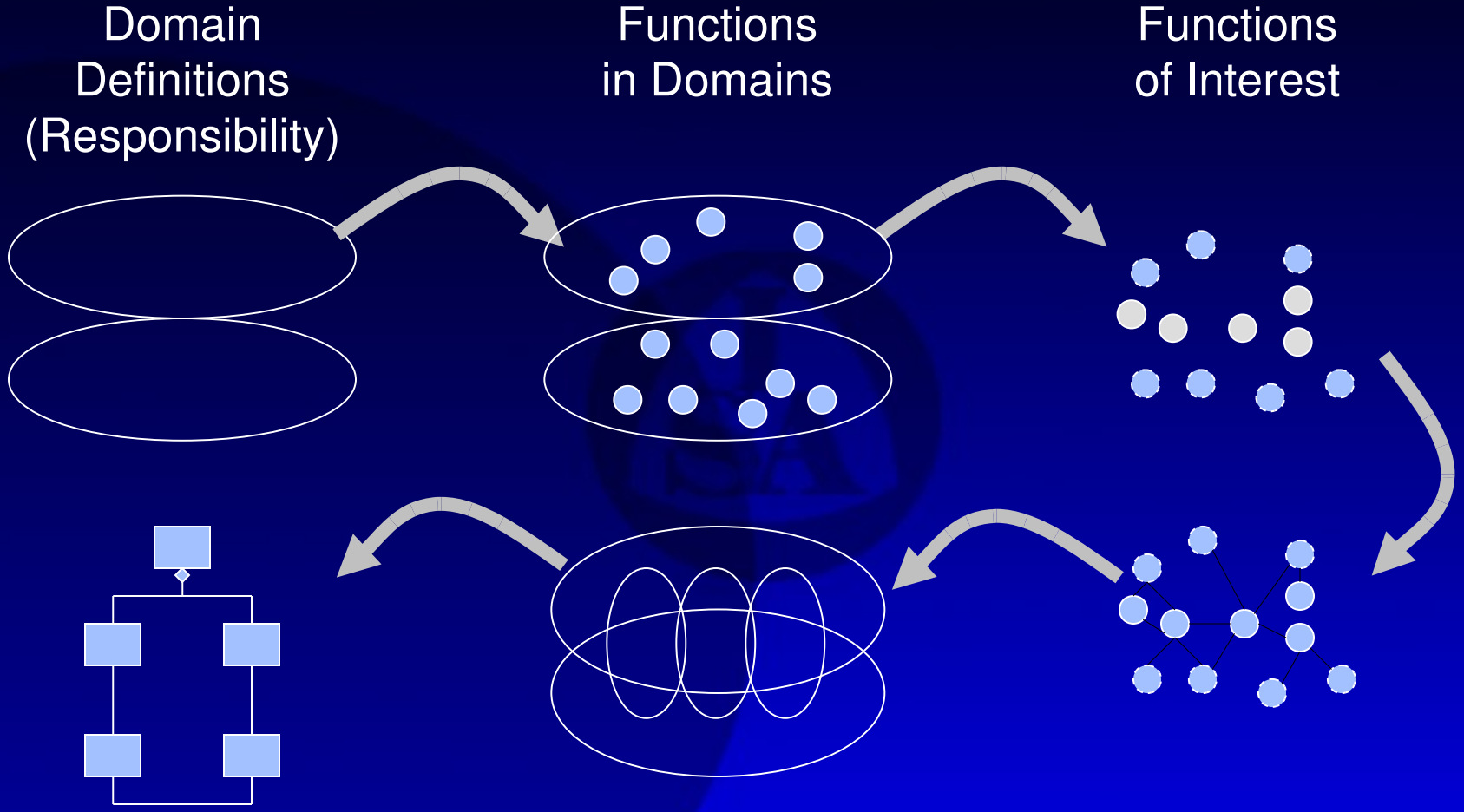
Scope of S95.01

- The definition of the scope of the manufacturing control domain
- A definition of the functions associated with the interface between control functions and enterprise functions
- A definition of the information which is shared between control functions and enterprise functions
- Based on the Purdue Reference Model for CIM and MESA model

SP95.01 Enterprise / Control Functional Model (PRM)

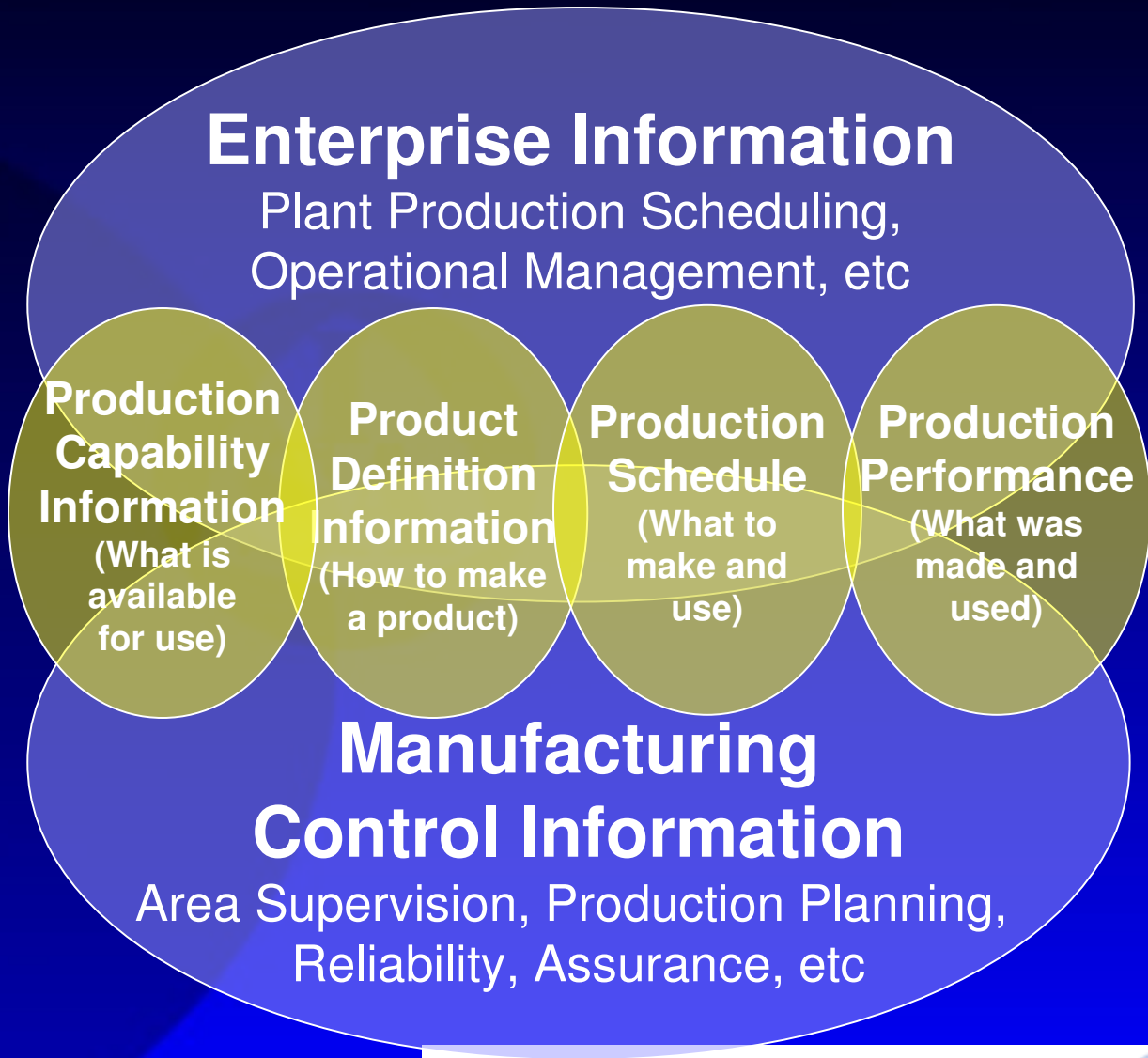


Elements of Models & Definitions



Identified Information Categories

- Data flow information was categorized
- Multiple Venn diagrams used to illustrate the overlap of information categories



Major Object Definitions

Resources

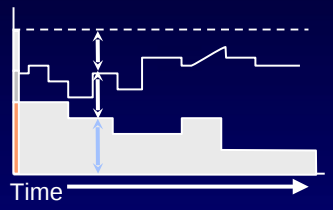
People

Equipment

Materials

Segments

Capability, Product, Production



Capabilities

Product Definitions

Production Schedule

Production Performance

Four Resource Object Models

People ← Personnel resources managed for production

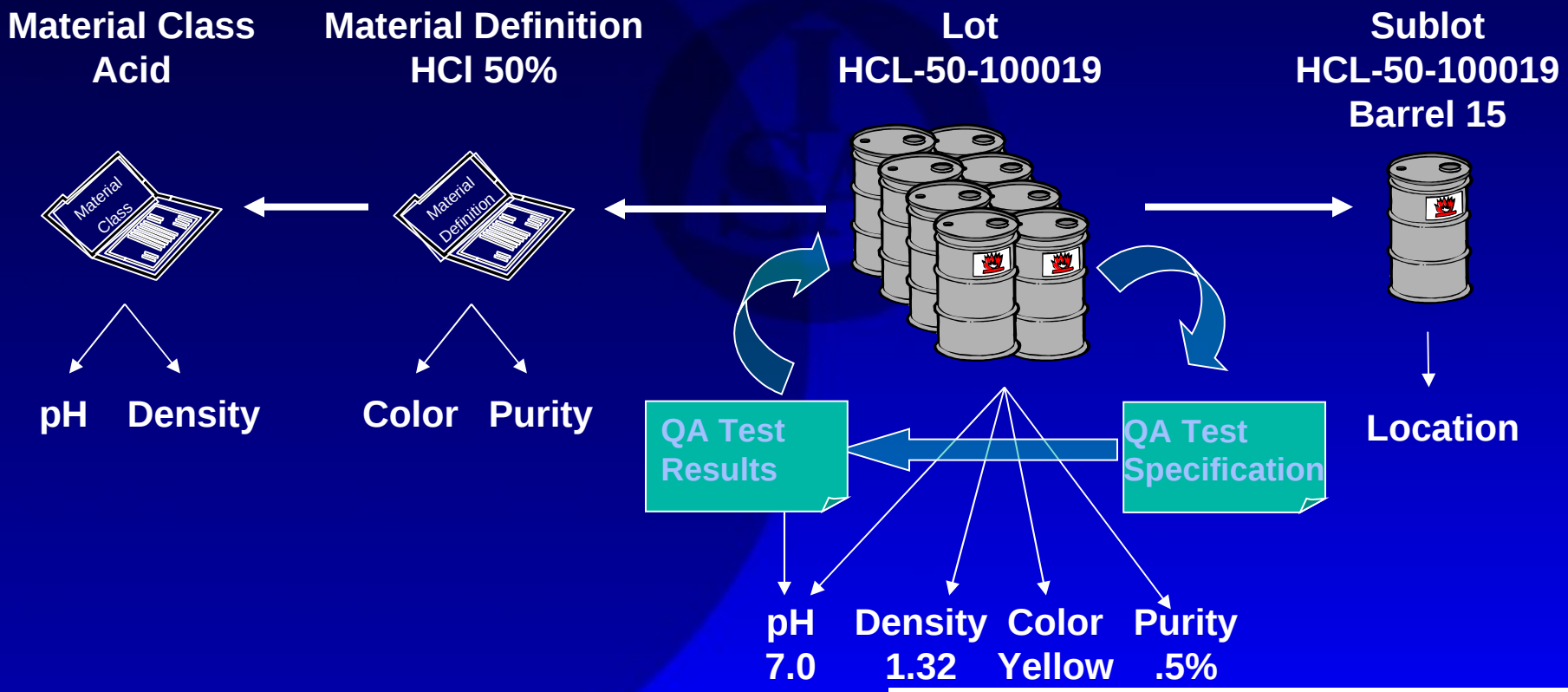
Equipment ← Equipment resources managed for production

Materials ← Material resources managed for production

Process Segments ← Business view of production processes

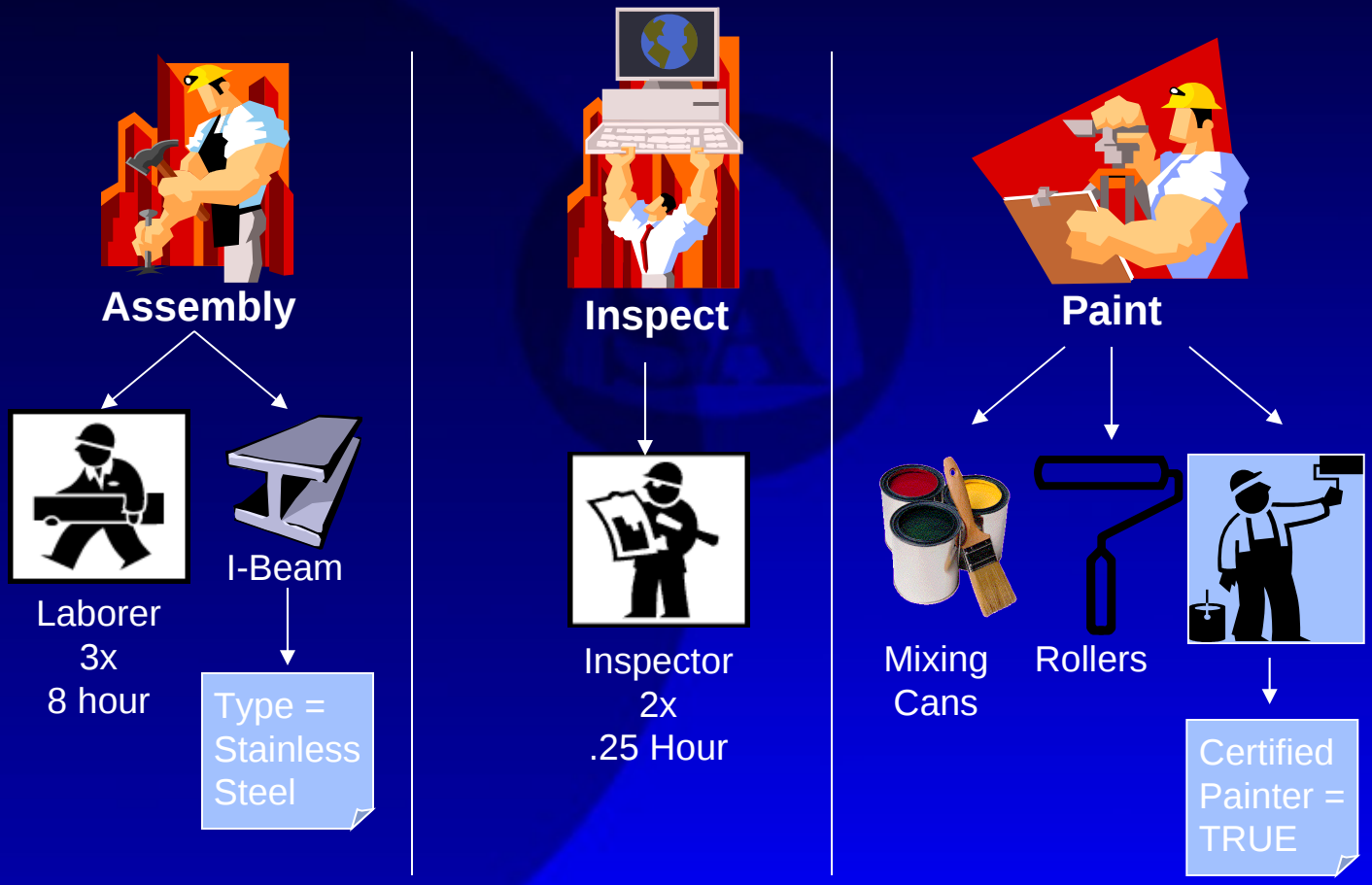
Material Definition Example

- Common material information

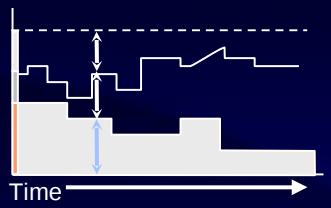


Process Segments

- Business view of production



Capability, Product, and Production Information



Capabilities

← What is available for use for production

Product Definitions

← What is needed to make a product

Production Schedule

← What to make and resources to use

Production Performance

← What was made and resources actually used

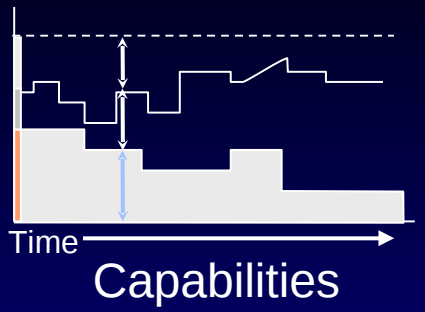
Capability Models

People

Equipment

Materials

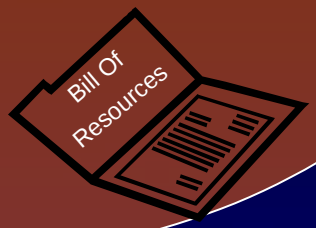
Segments



Per Product Definitions

Scheduling System

Bill Of Resources
e.g. 10 Speed Bicycle



Product Segments

Frame Assembly

Frame Type

Final Assembly

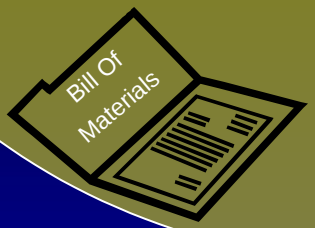
Seat Height

Paint

Color

Material System

Bill Of Materials
e.g. 10 Speed Bicycle

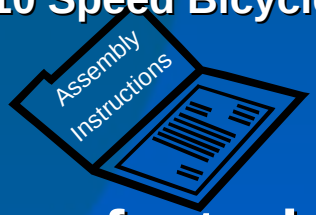


Manufacturing Bill

Frame : 1
Wheels : 2
Chain : 1
Seat : 1
Handlebars :1
Brake Pads : 4
...

Manufacturing System

Production Rules
e.g.
10 Speed Bicycle



Production Schedule

People

Equipment

Materials

Segments

Product Definitions

Production Schedule

Production Performance

People

Equipment

Materials

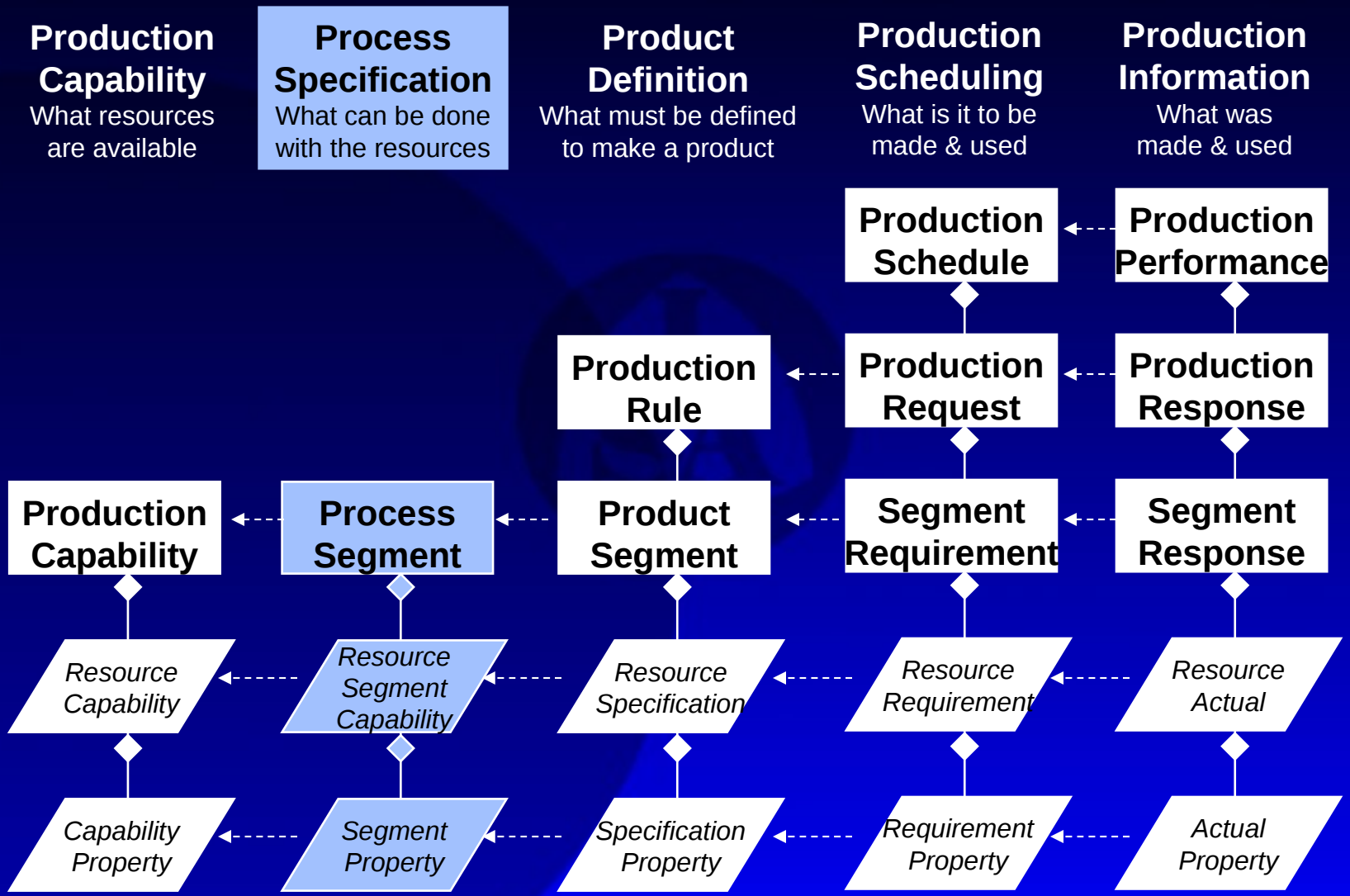
Segments

Product Definitions

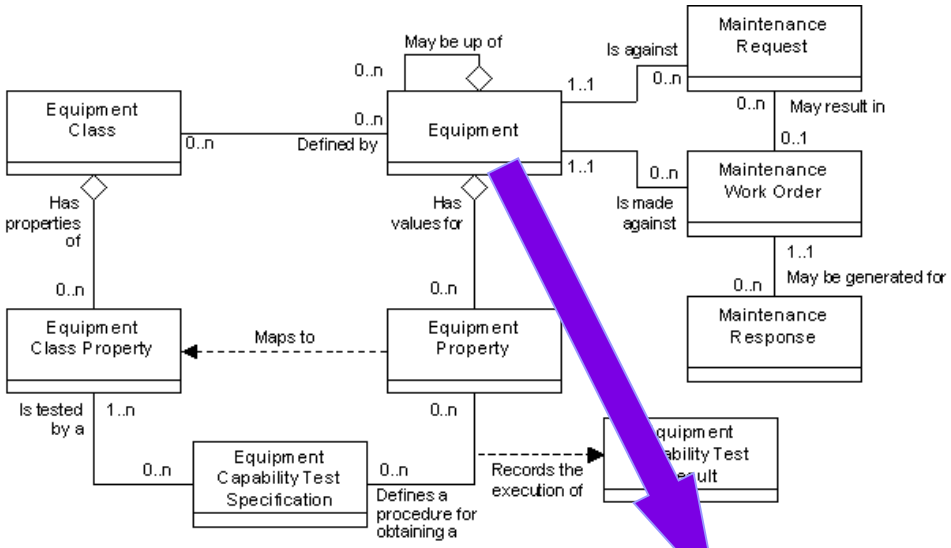
Production Schedule

Production Performance

Four Models & Segment Resources



ISA 95.00.02 : Relationship with Part 1



ISA95.01 Equipment model

dISA95.02 Equipment Attributes

Attribute Name	Description	Examples
ID	A unique identification of a specific piece of equipment, within the scope of the information exchanged (Production Capability, Production Schedule, Production Performance, …) The ID is used in other parts of the model when the equipment must be identified, such as the *production capability* for this person, or a *production response* identifying the equipment.	R7726 Reactor 101 Lathe machine 33
Description	Additional information about the equipment.	

ISA 95.00.03 : Level 3 Functions

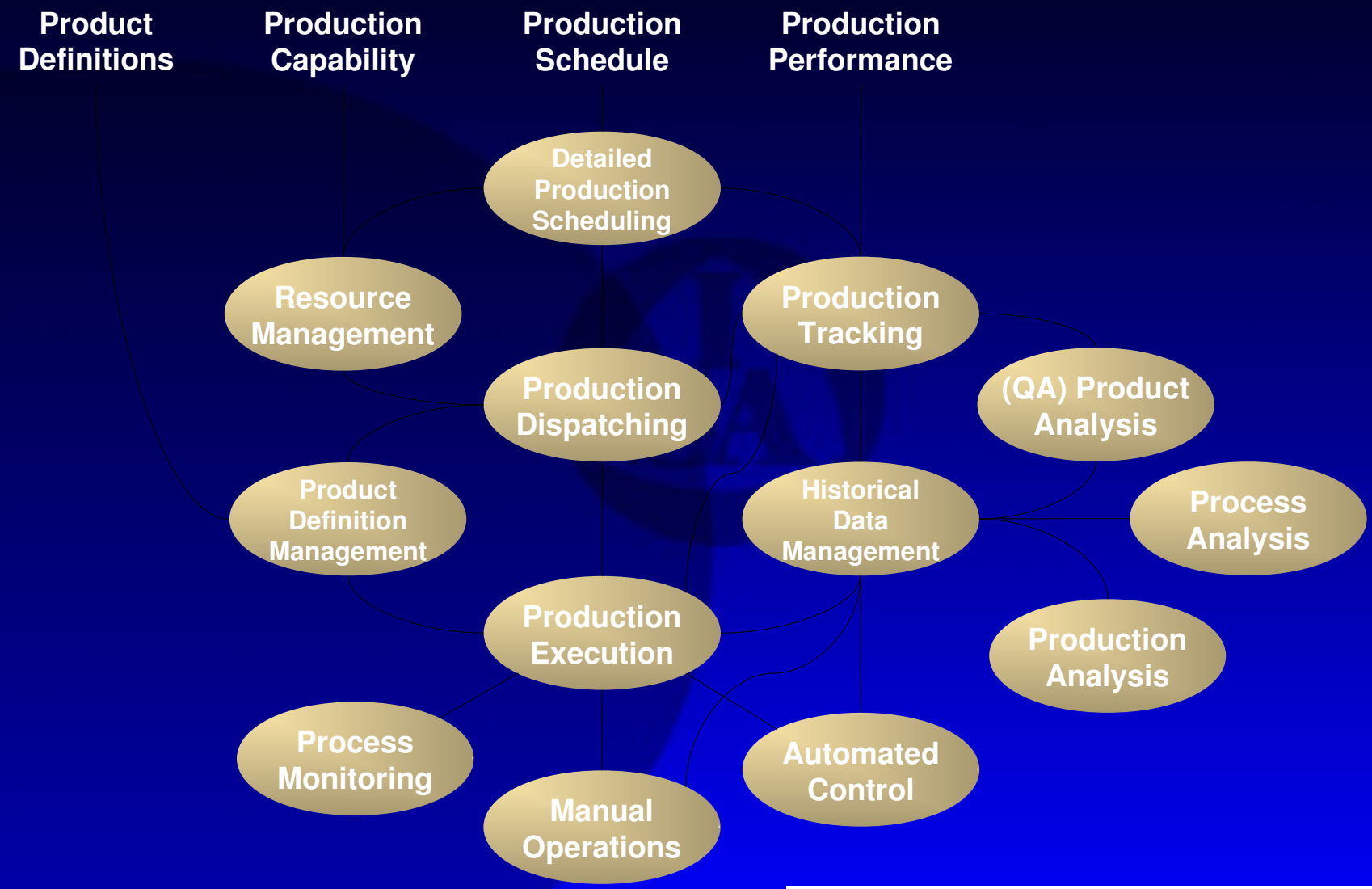
MESA Definitions

- Operations and Detailed Scheduling
- Production Tracking
- Dispatching Production
- Resource Allocation and Control
- Data Collection and Data Acquisition
- Quality Management
- Process Management
- Performance Analysis
- Interface to
  - Document Control
  - Labor Management
  - Maintenance Management

d95.03 Definitions

- Detailed Production Scheduling
- Production Tracking
- Production Dispatching
- Resource Management
- Historical Data Management
- (QA) Product Analysis
- Process Analysis
- Production Analysis
- Product Definition Management
- Process Monitoring
- Manual Operations
- Automated Control

d95.03 Manufacturing Operations Functions

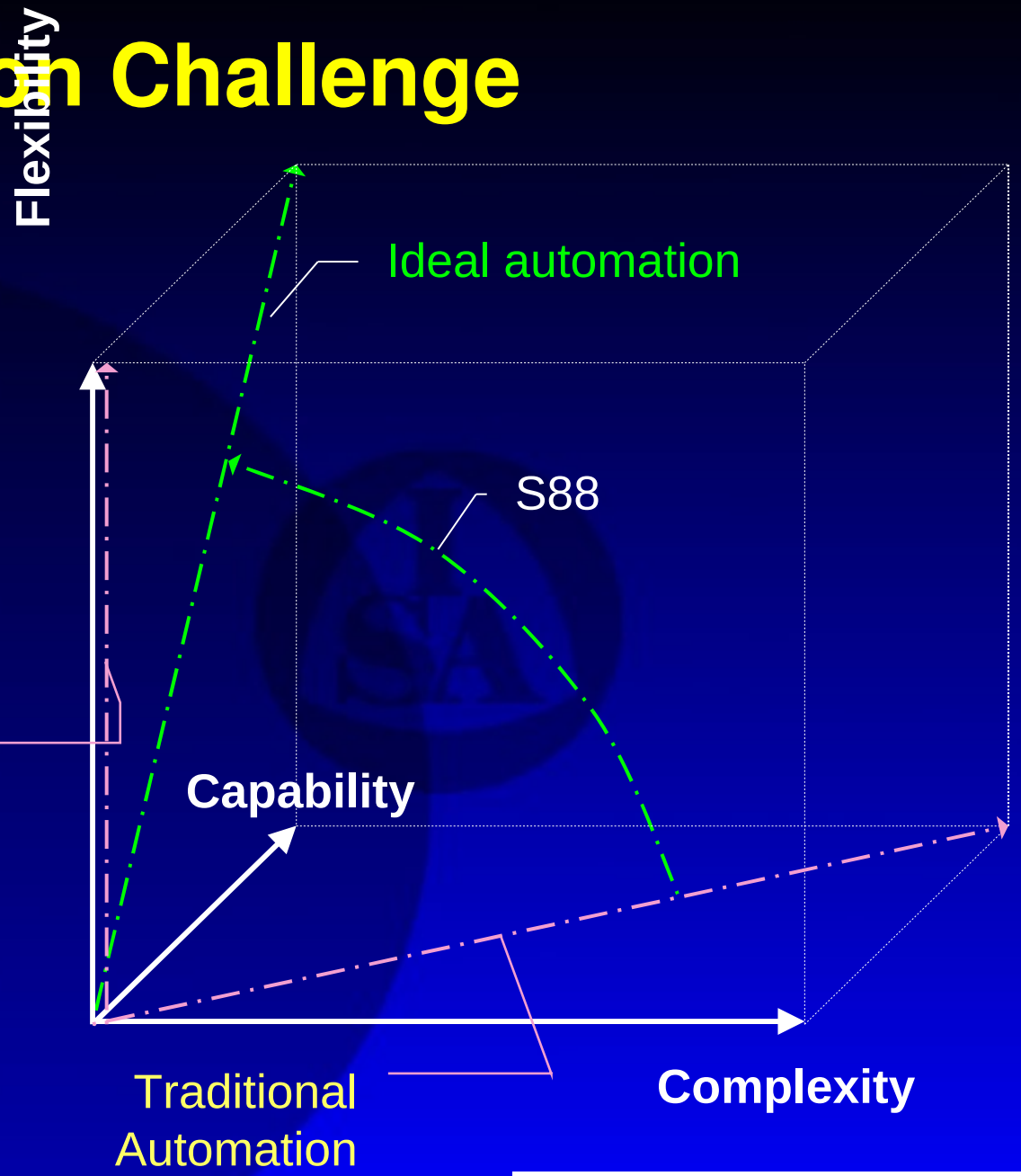


ISA 88 : Modular control

What is ISA 88 ? - Status

- Standard ANSI/ISA 88 « Batch Control »
- Comité SP88 lancé en 1988
- Partie 1 – ISA 88.00.01
  - Publiée et disponible à l'ISA et à l'ANSI
  - IEC 61512-1 bilingue disponible auprès de l'IEC, l'UTE et l'AFNOR
- Partie 2 – ISA 88.00.02
  - Publication imminente
  - Version IEC (61512-2) bilingue pour 2001?
- Partie 3 – ISA 88.00.03
  - Début des travaux

Automation Challenge



Darin Flemming
Lou Pillai

The Powerful Tyrex…

- Big brain
- Centralized design
- OK for steady / slow changing environment
- Shortcomings
  - Agility
  - Availability
- Refer to first computerized systems

…vs Stupid Bird

- Limited intelligence
- Mostly decentralized design
  - Local decision making at feather level
  - Cope well with unexpected situations
  - Inherently adaptative structure

From Goal to Labor

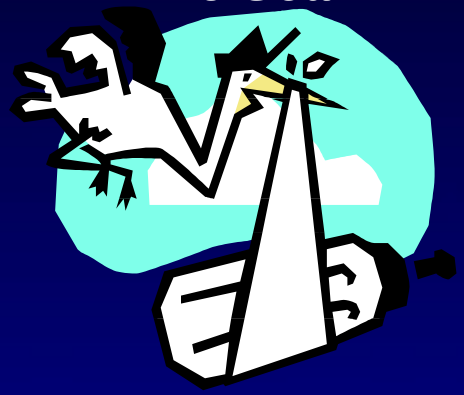
Forecasting, Planning And Scheduling

Process Control Definition

Equipment Functional Capabilities

Elementary Equipment Control

The Goal:



chirping

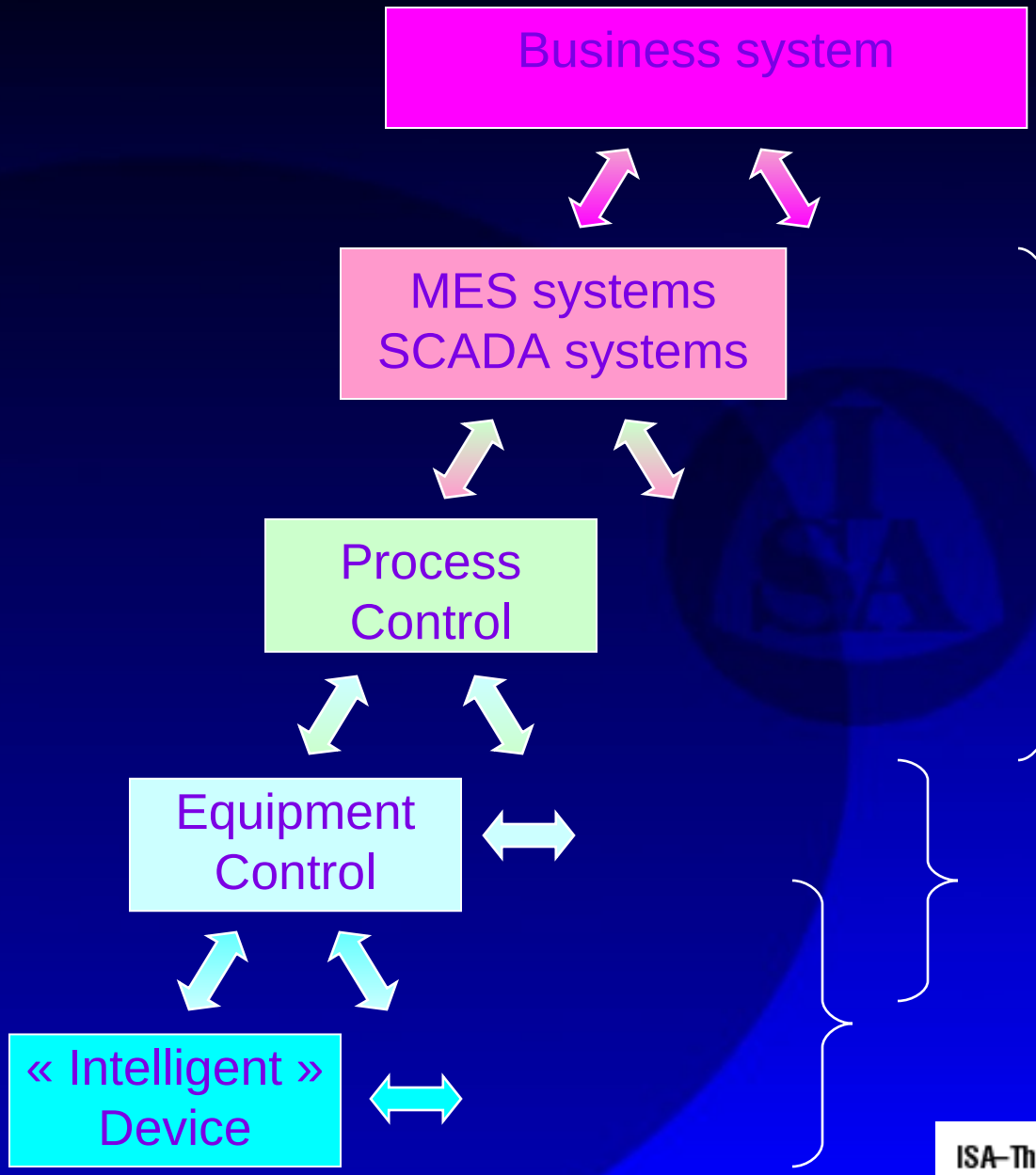
Eating

Love.

Walking

I know What/How To do

Scheduling hierarchy



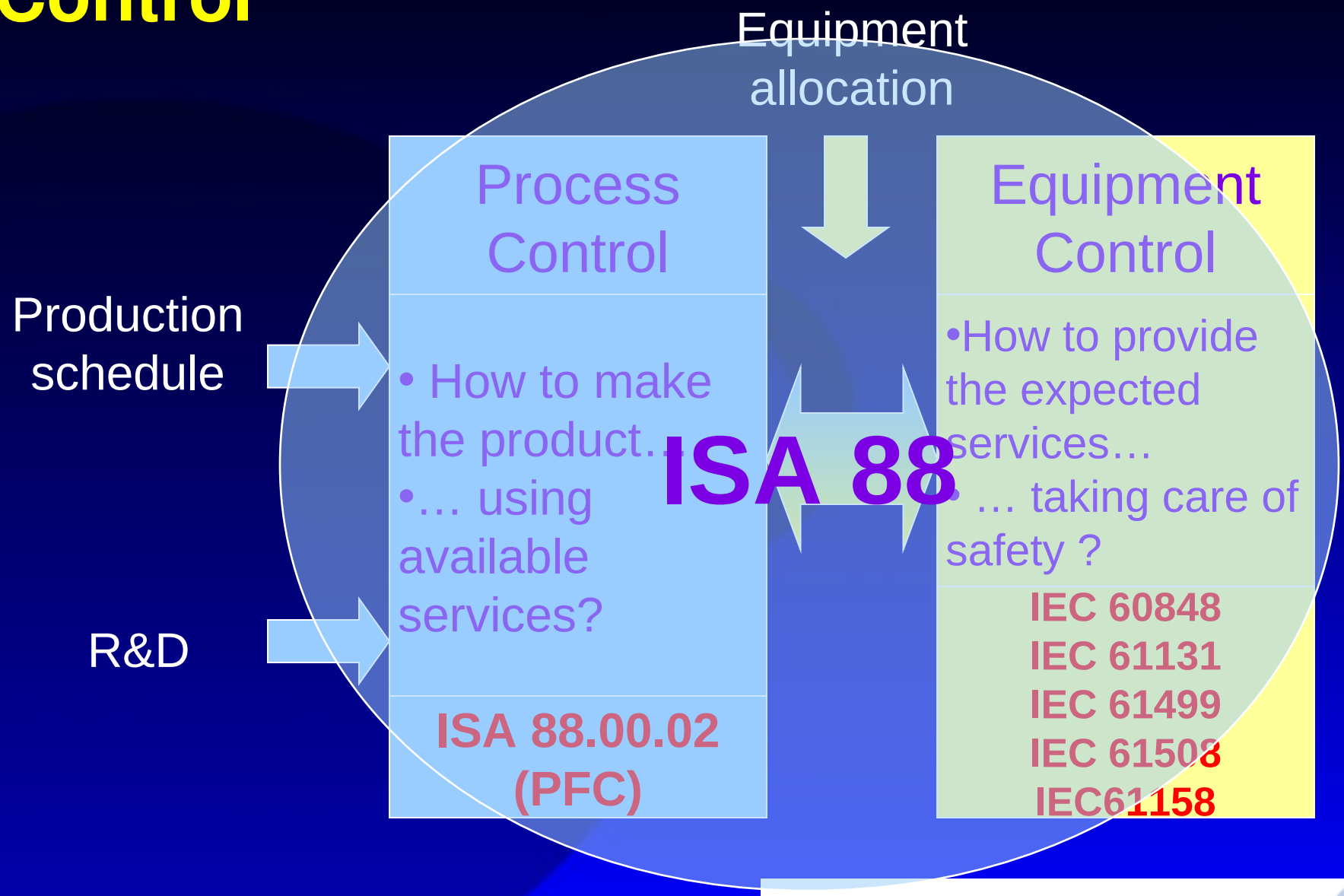
ISA 95

ISA 88
IEC 61512
OPC

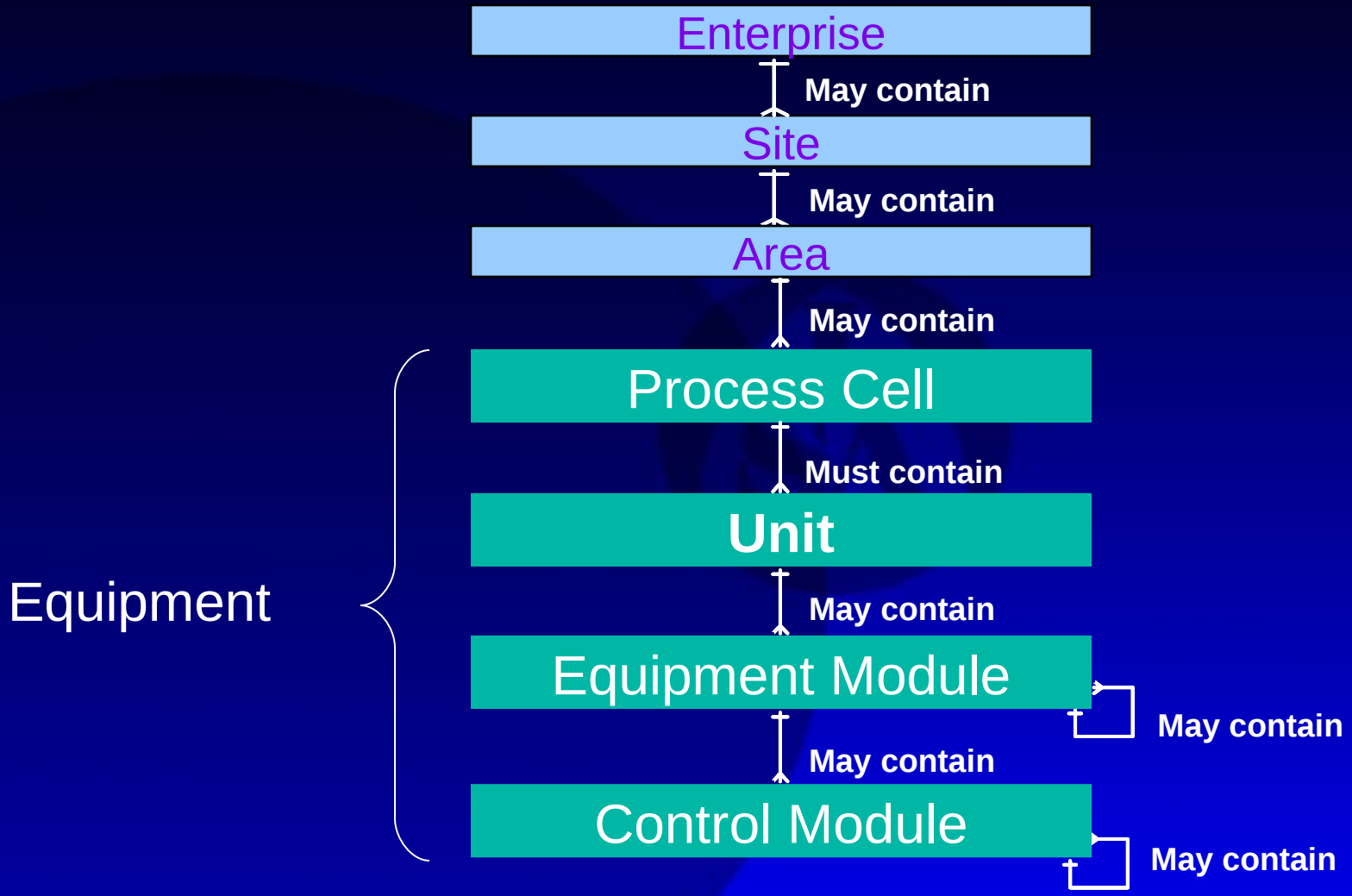
IEC 61131
IEC 61499

IEC 61158
Fieldbus

Product Processing / Equipment Control

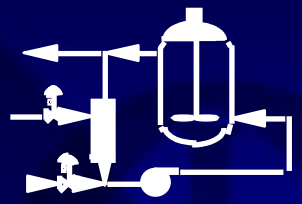


ISA 88 Physical Model



Equipment Entities -An Object Approach

Physical Equipment

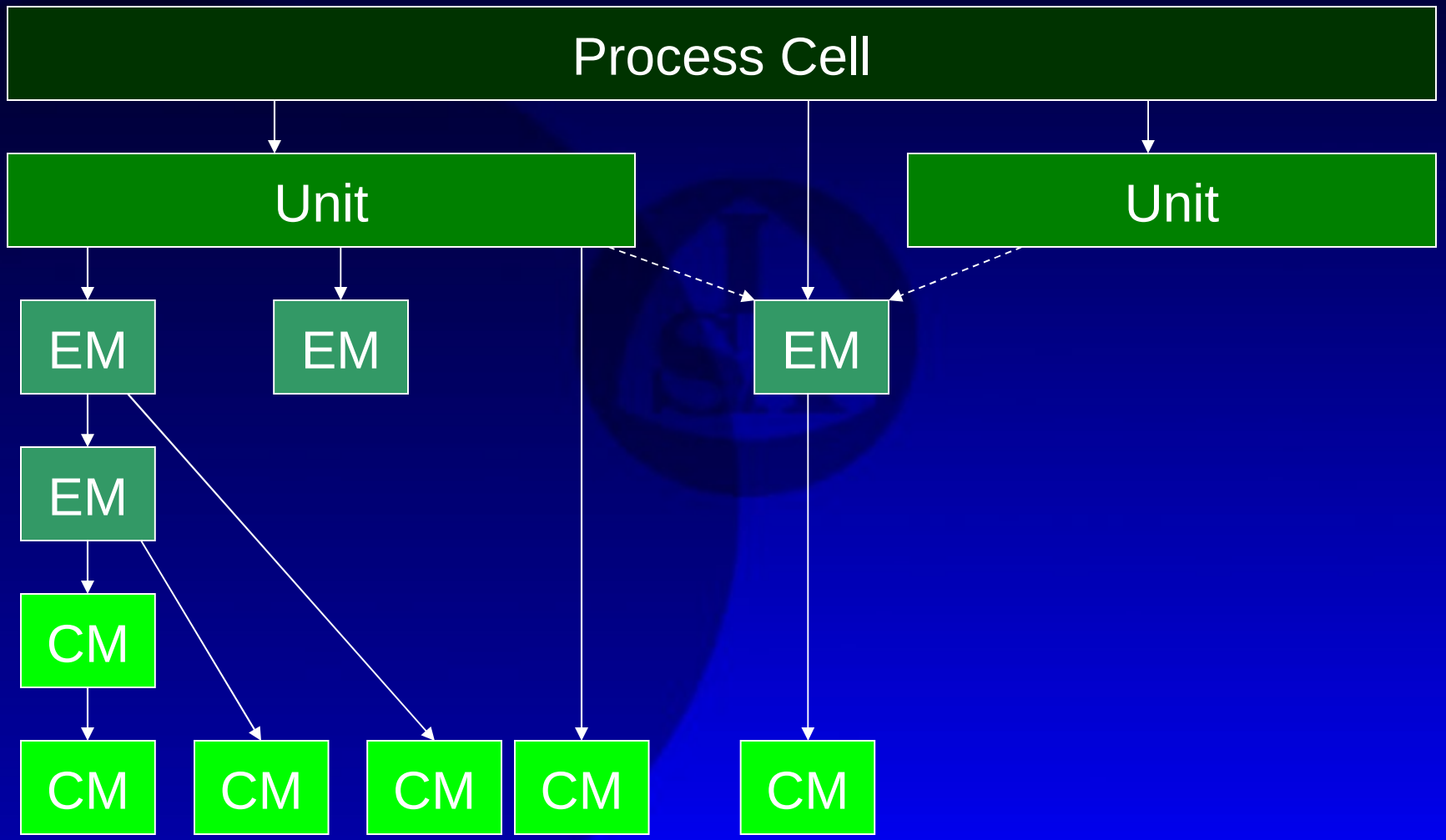


Equipment Entities

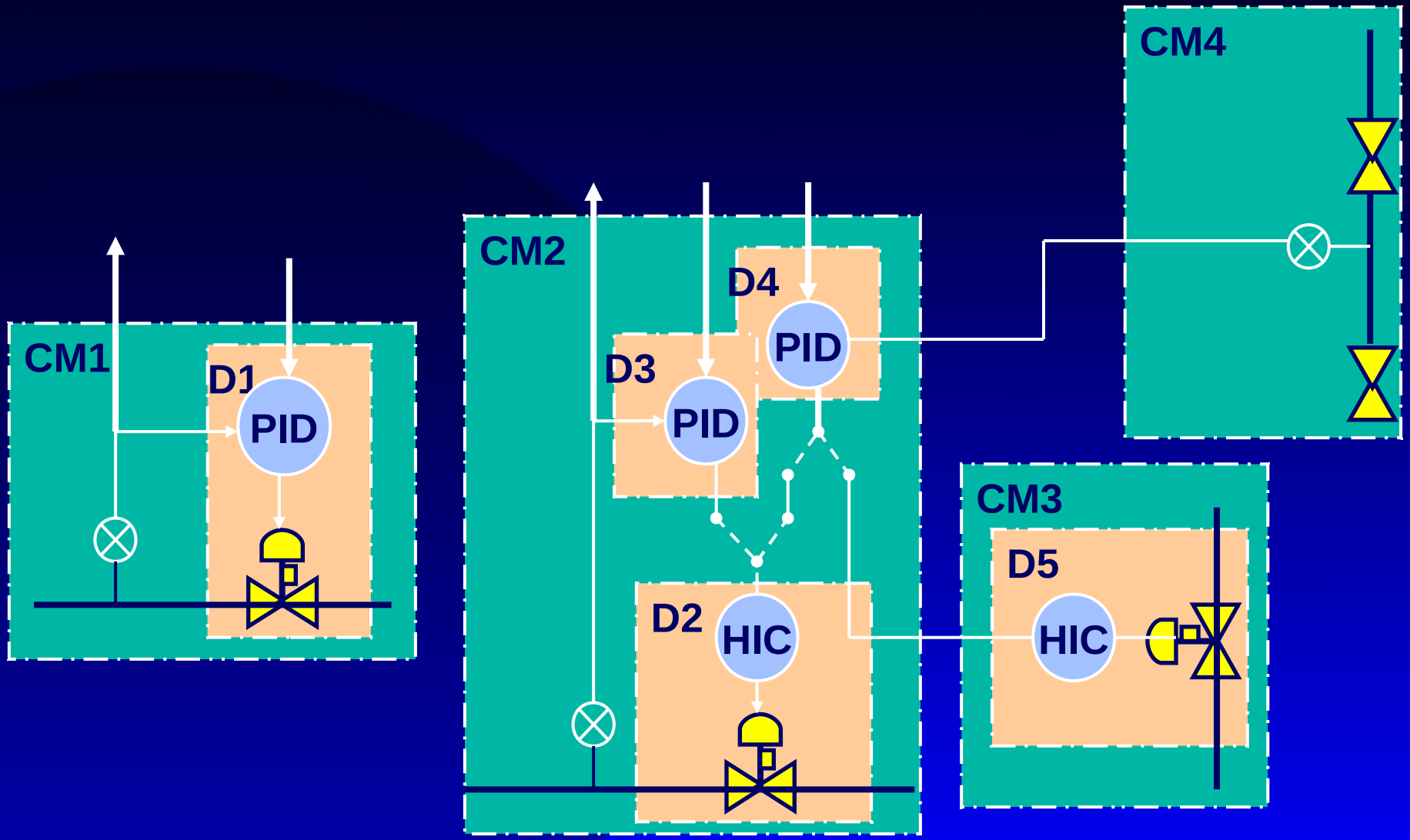
Equipment Control

- Instruments
- Basic control
- Coordination control
- Procedural control

Example of physical modeling

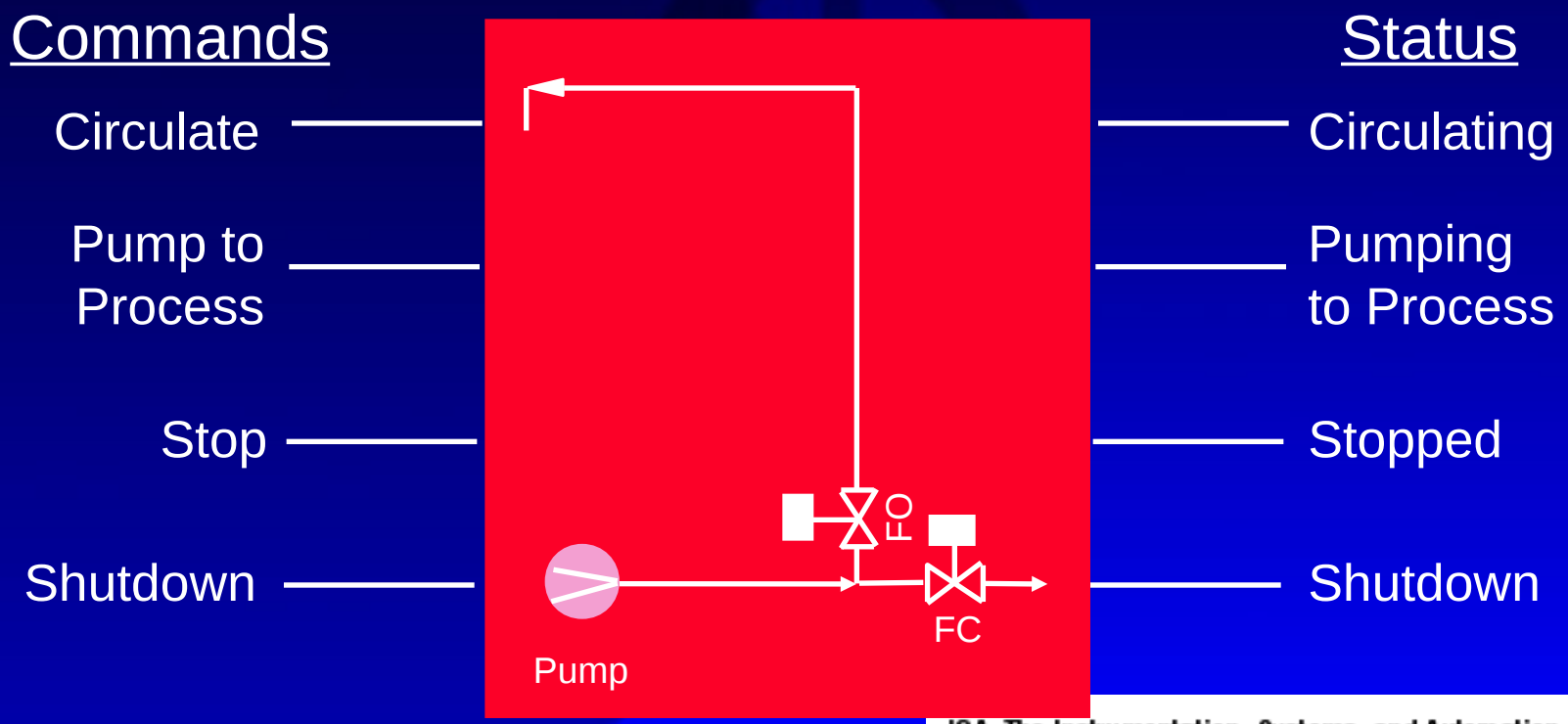


Example of control modules



Why Control Modules

Treating as a control module simplifies the interface to this group of objects



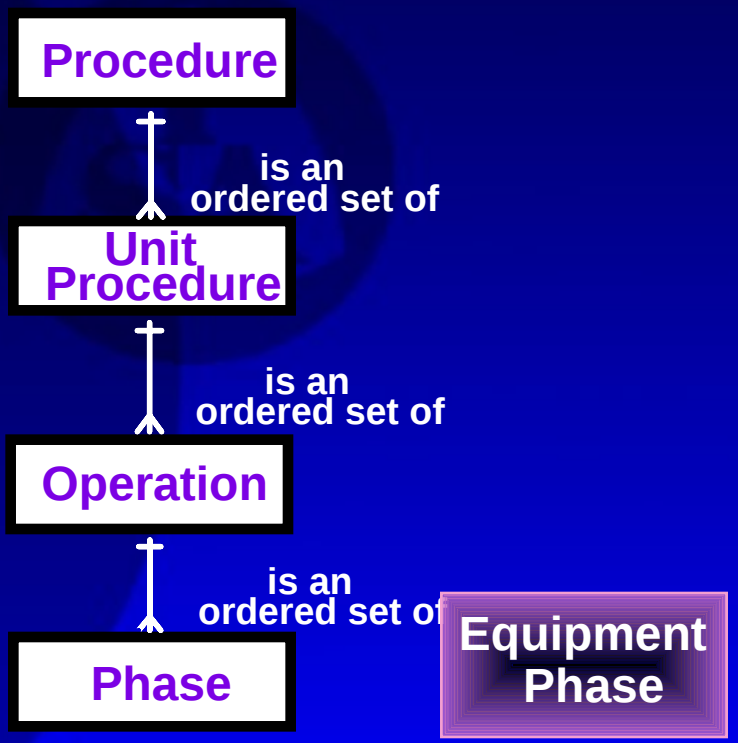
Recipe/Equipment Control Separation

Control Recipe Procedure

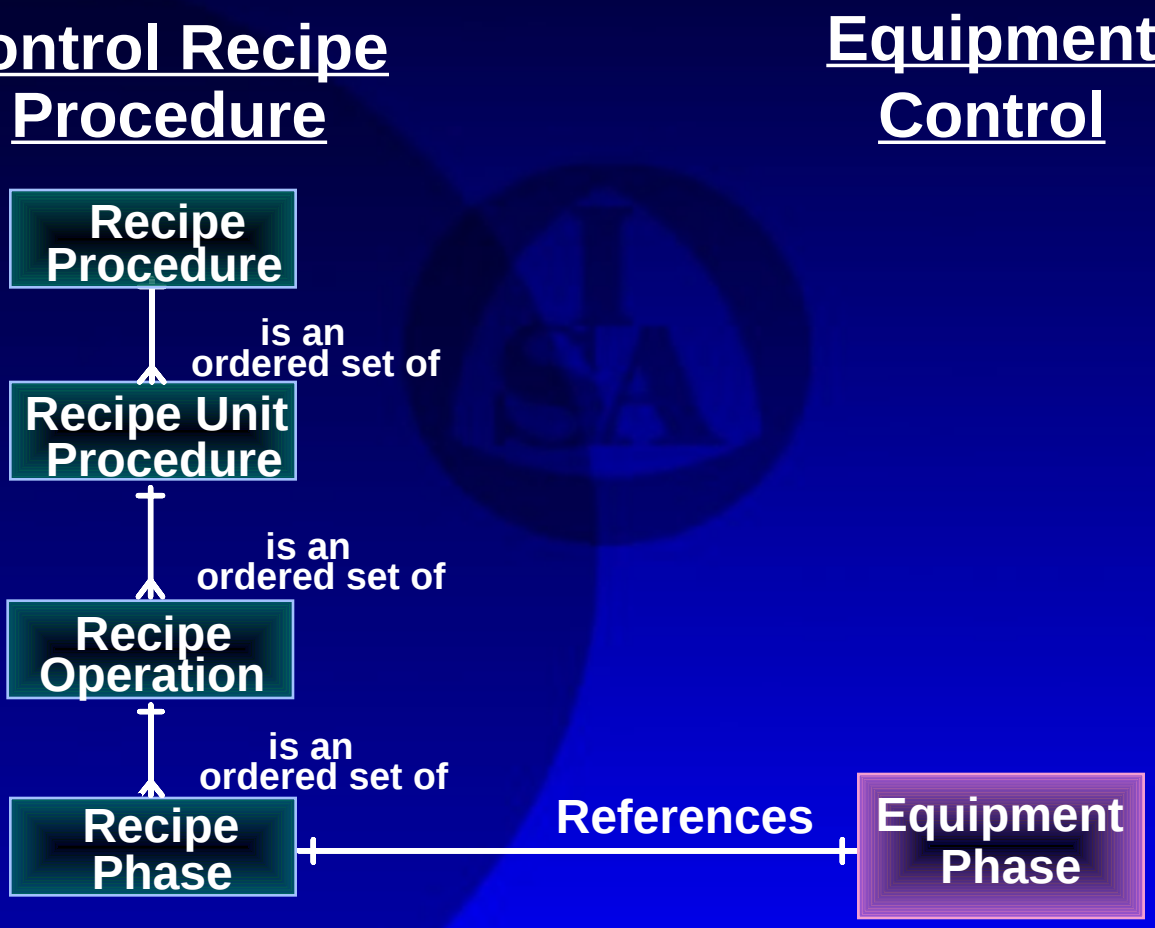
Recipe Procedure

[Must Always Exist]

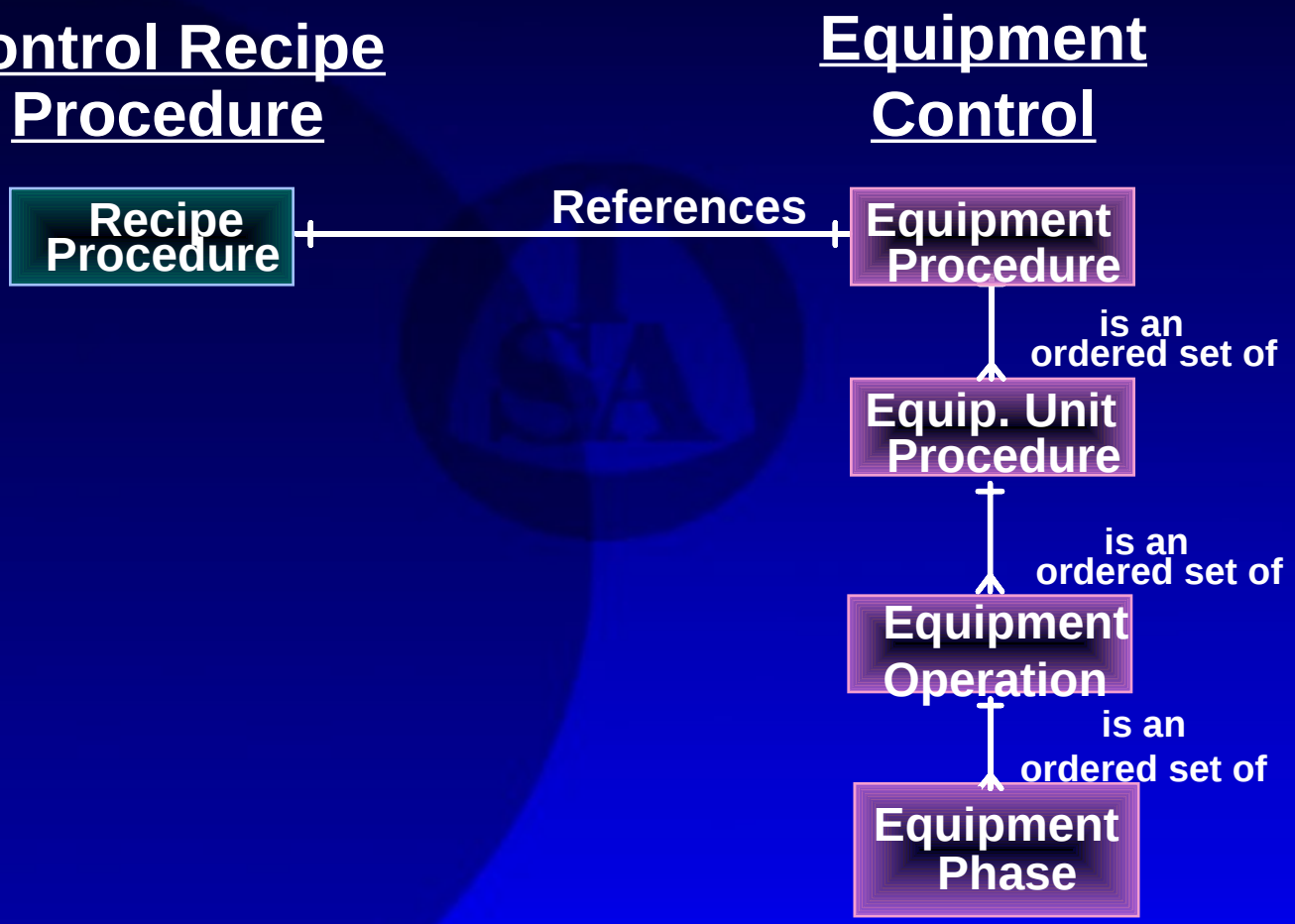
Equipment Control



Recipe/Equipment Control Separation - Typical

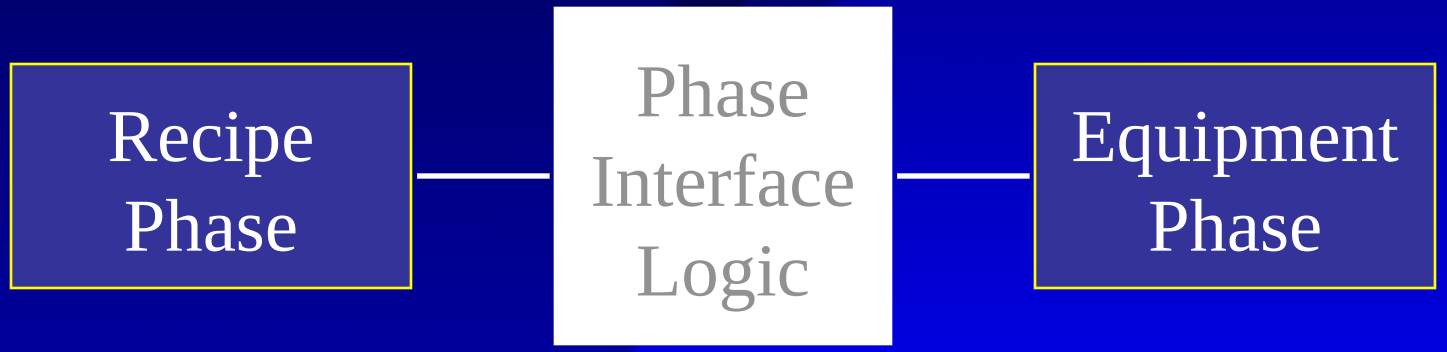


Recipe/Equipment Control Separation - Alternate 3

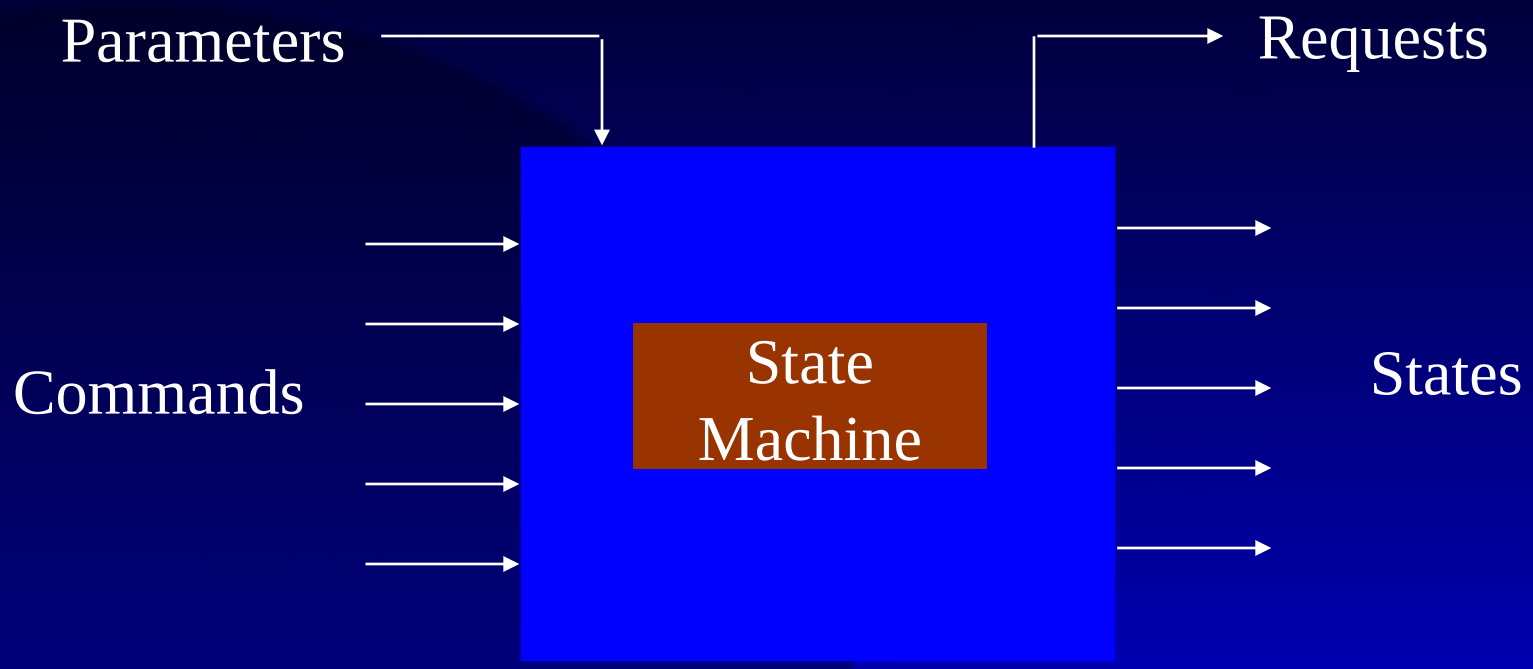


Phase Interface Logic

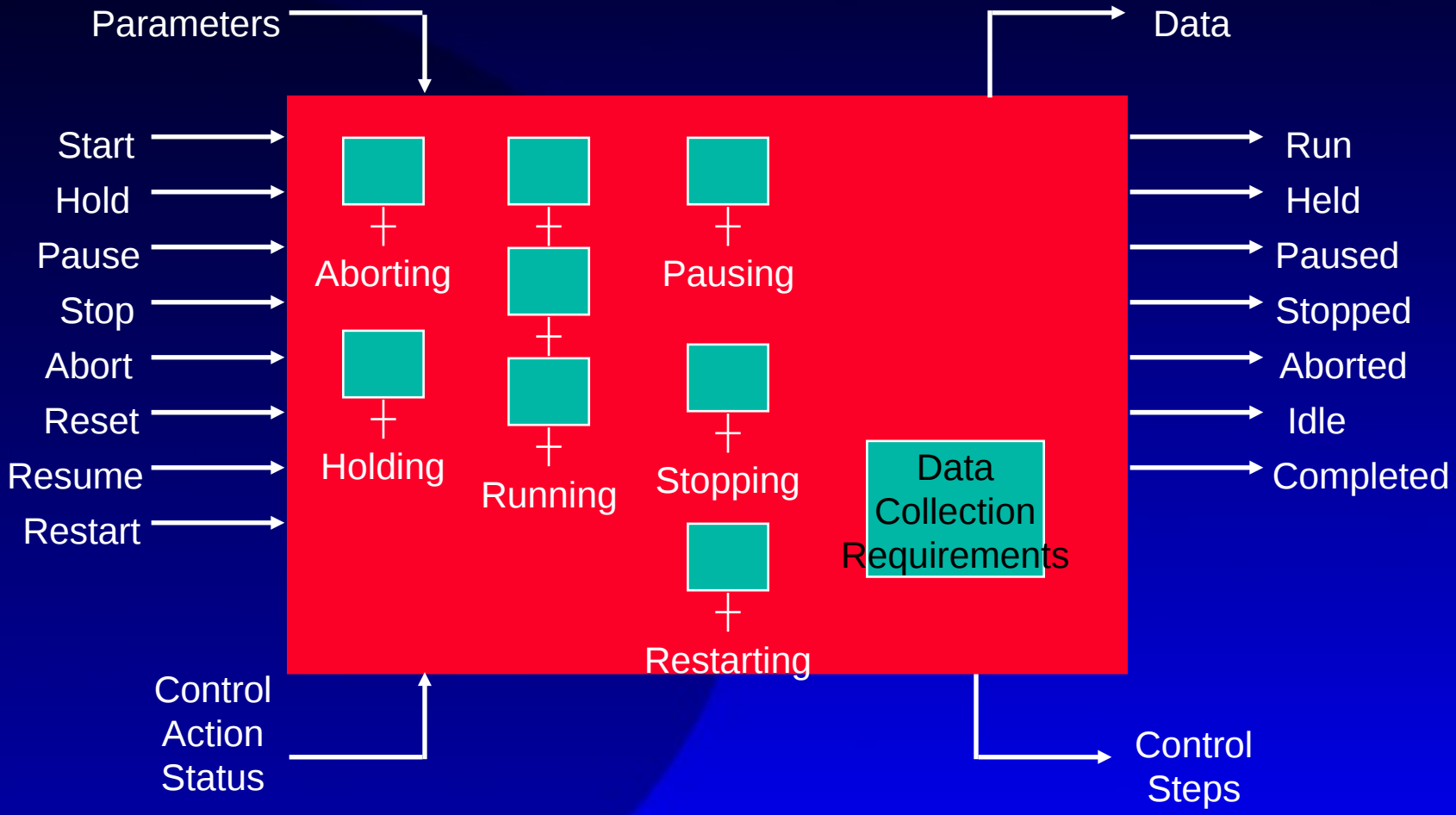
- State machine enforcement between recipe phase and equipment phase
- A set of services that support commands to the equipment phase
- A set of services that support requests from the equipment phase to the recipe phase



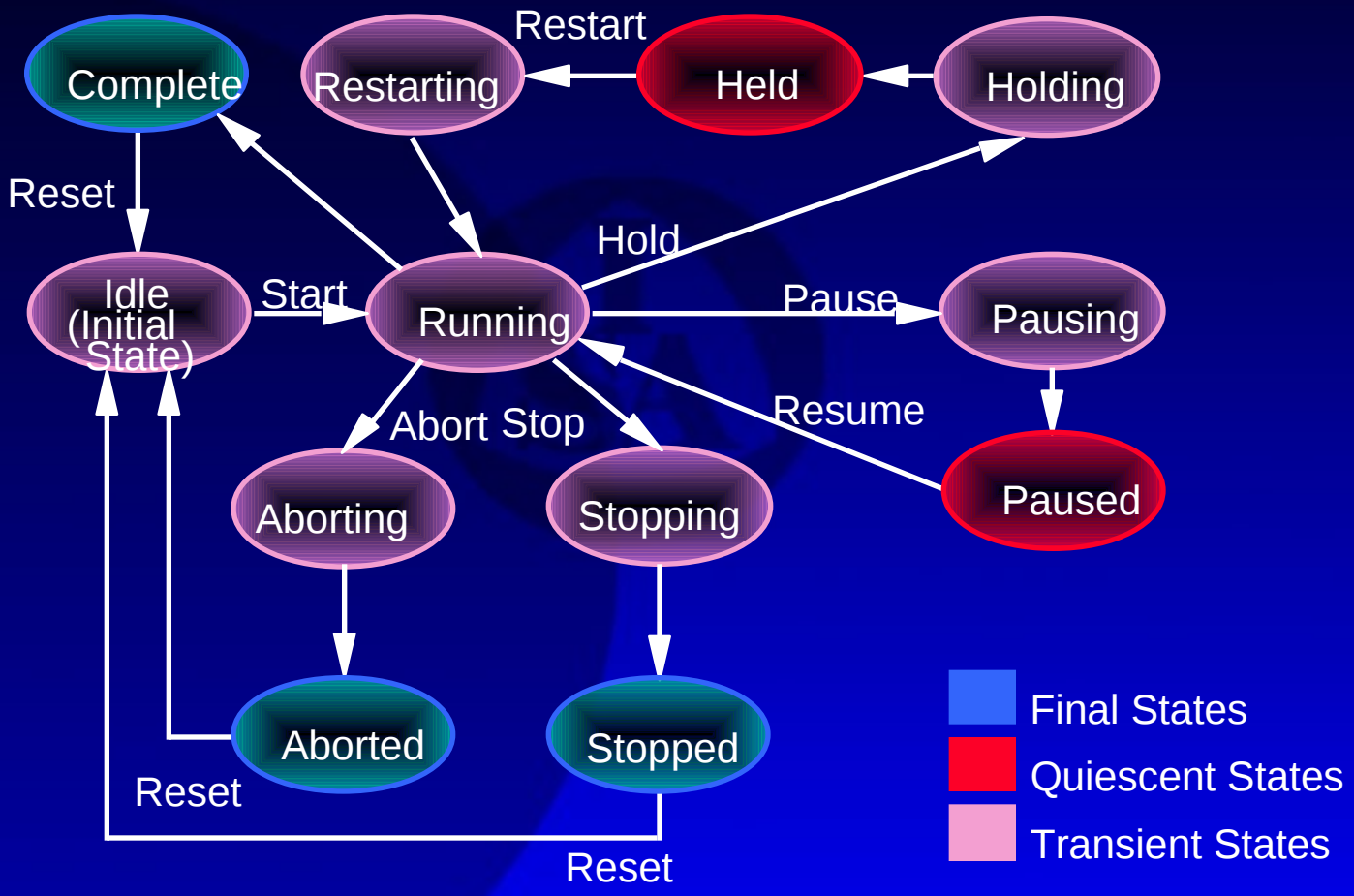
Phase Interface Logic



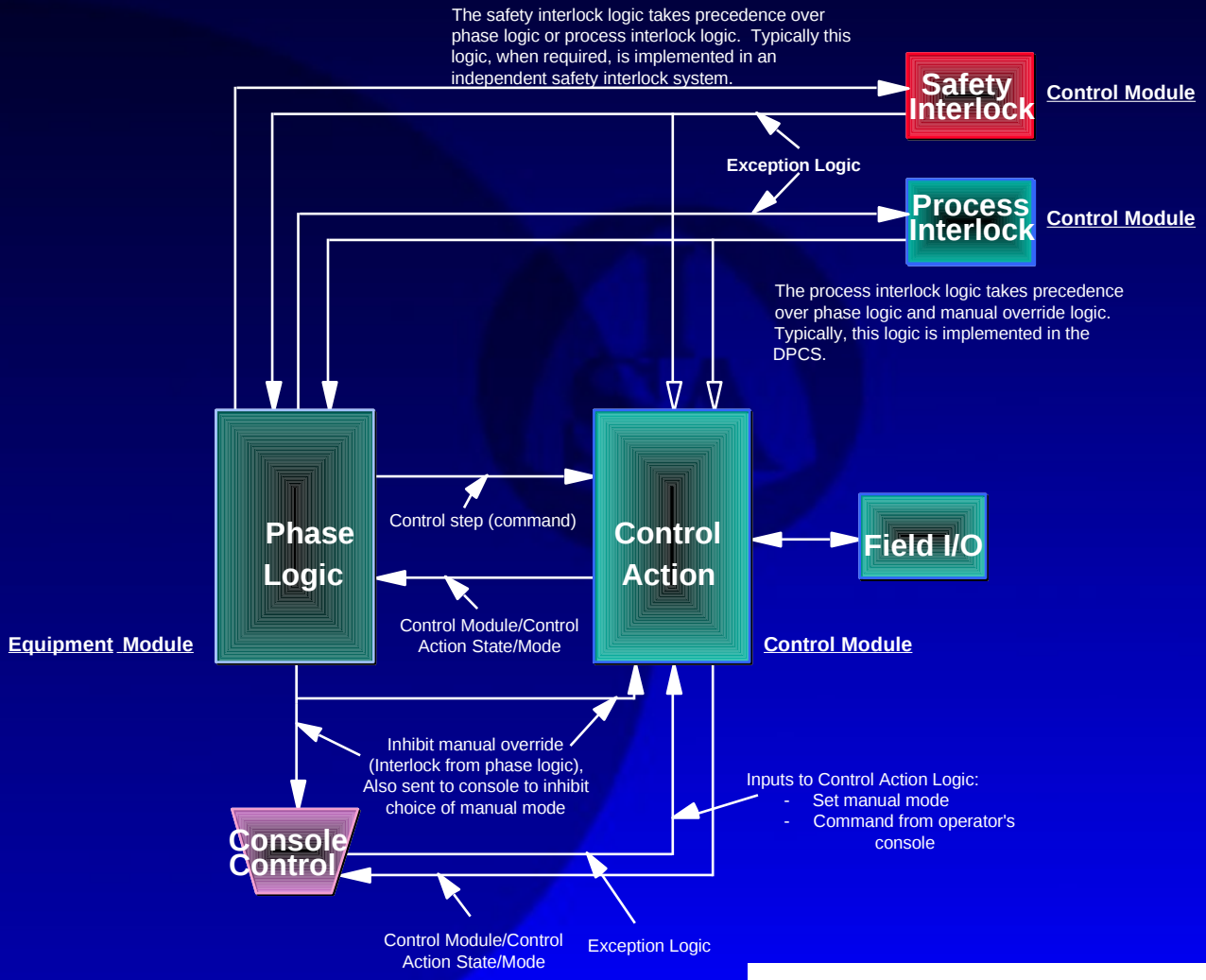
Phase Object



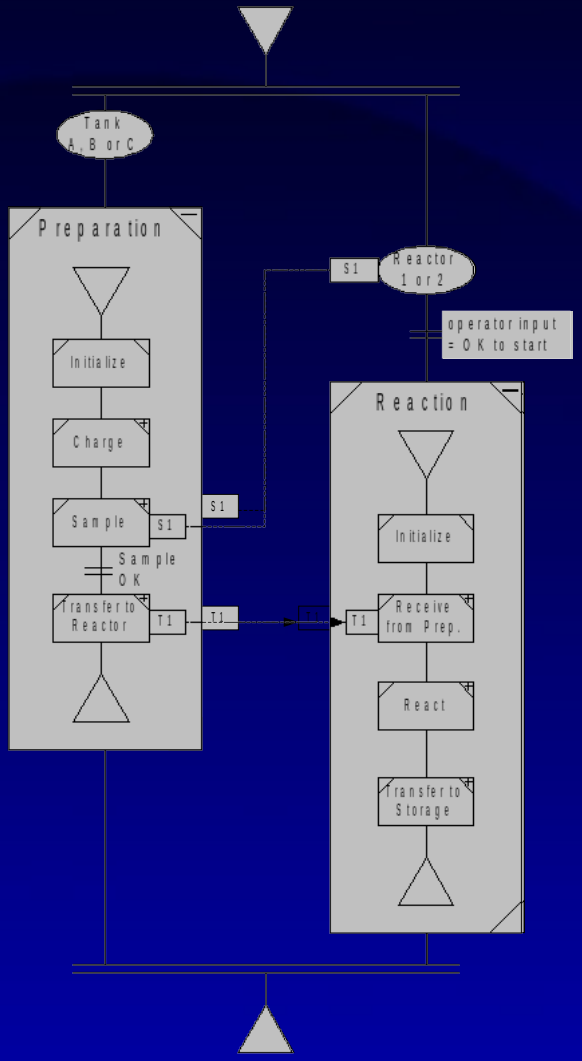
Example Procedural Element States



Exception Handling In Control Actions



ISA 88.00.02 : Procedural Function Chart



- Unit procedure interactions
- Relative timing
  - Height of unit procedure symbol
  - Vertical placement of symbols
  - Master recipes do not contain absolute timing
- Synchronization points
  - Arrowheads indicate material transfer
- Multiple levels of procedures
  - Encapsulation (contents) of unit procedure revealed

THANK YOU