

Overview of the EIA 632 Standard - “Processes for Engineering a System” (TUTORIAL G)

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EIA 632 Working Group Chairman
Raytheon Systems Company***

❖ Background

- » Role of the Standard
- » Evolution of the Standard

❖ Document Contents

- » Process Description
- » Key Concepts

Background

- **US National Standard Co-Developed by**
 - » Electronic Industries Alliance (EIA)
 - » International Council on Systems Engineering (INCOSE)
- **Under Development since 1994**
 - » Release as ANSI/EIA Standard planned for November 1998
- **Intended for Voluntary Compliance**
 - » Should not be imposed on contract
 - » Should be used to develop company practices

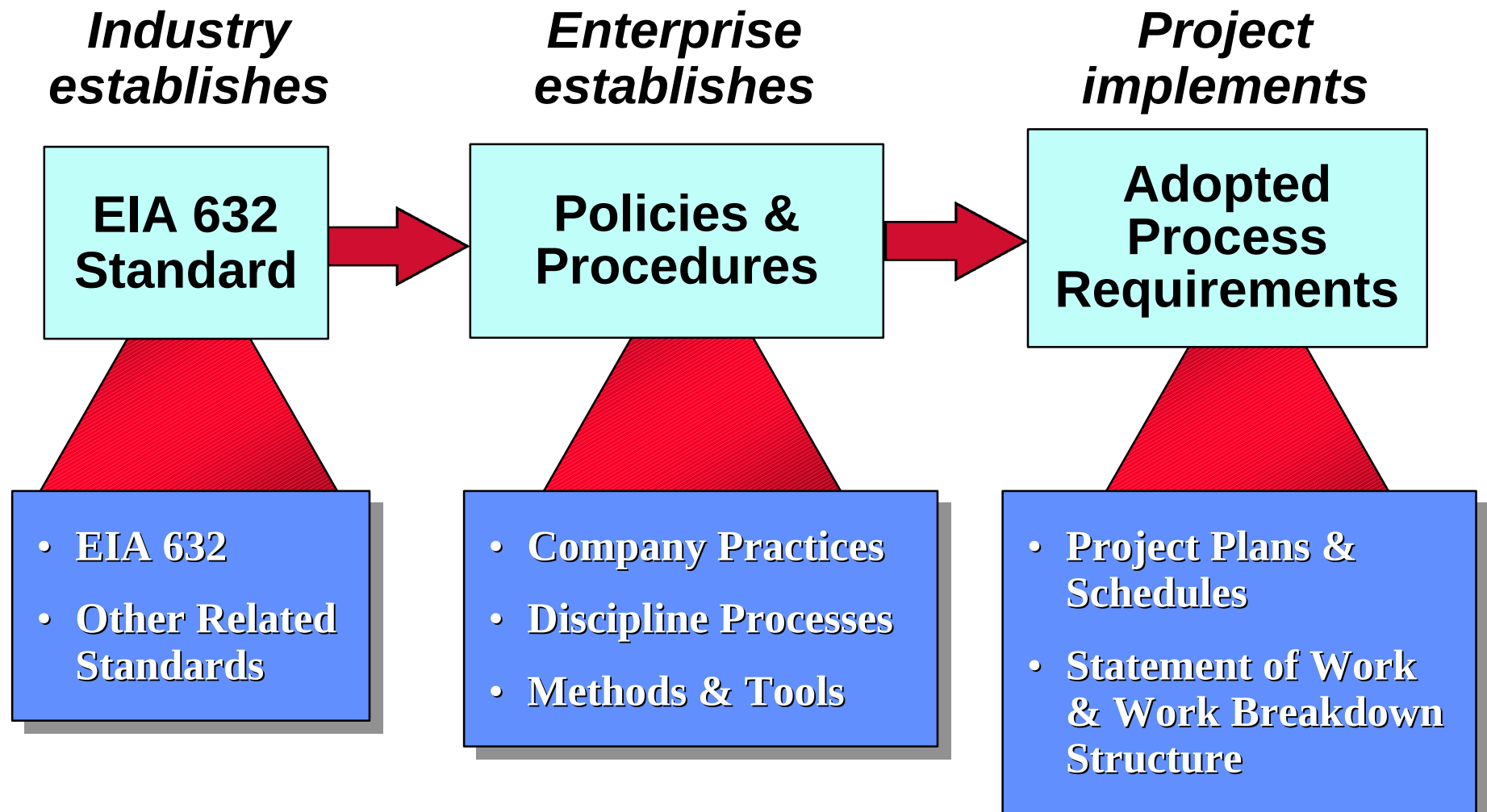
Contents

- **Thirteen Processes**
 - » Representative Tasks for each Process
 - » Expected Outcomes for each Task
- **33 Requirements on these Processes**
- **Key Concepts**
 - » System includes not just End Products, but also Enabling Products
 - » Building Block is the basic unit of a System
 - » Systems developed in “layers”

What is the role of Systems Engineering?

- **This Standard does NOT define “Systems Engineering”**
 - » **What SE is**
 - » **What SE does**
 - » **Who does SE**
- **SE should be “Keeper” of the Process, Methods & Tools**
 - » **Coordinator of the process activities**
 - Like a conductor of an orchestra
 - This standard is like the original composition
 - The engineering plan is the musical score specially arranged for a particular project
 - » **Establishes the “Shared Vision” of the System Solution**
 - Maintains the requirements and architecture
 - Leads the technical effort

Role of the EIA 632 Standard

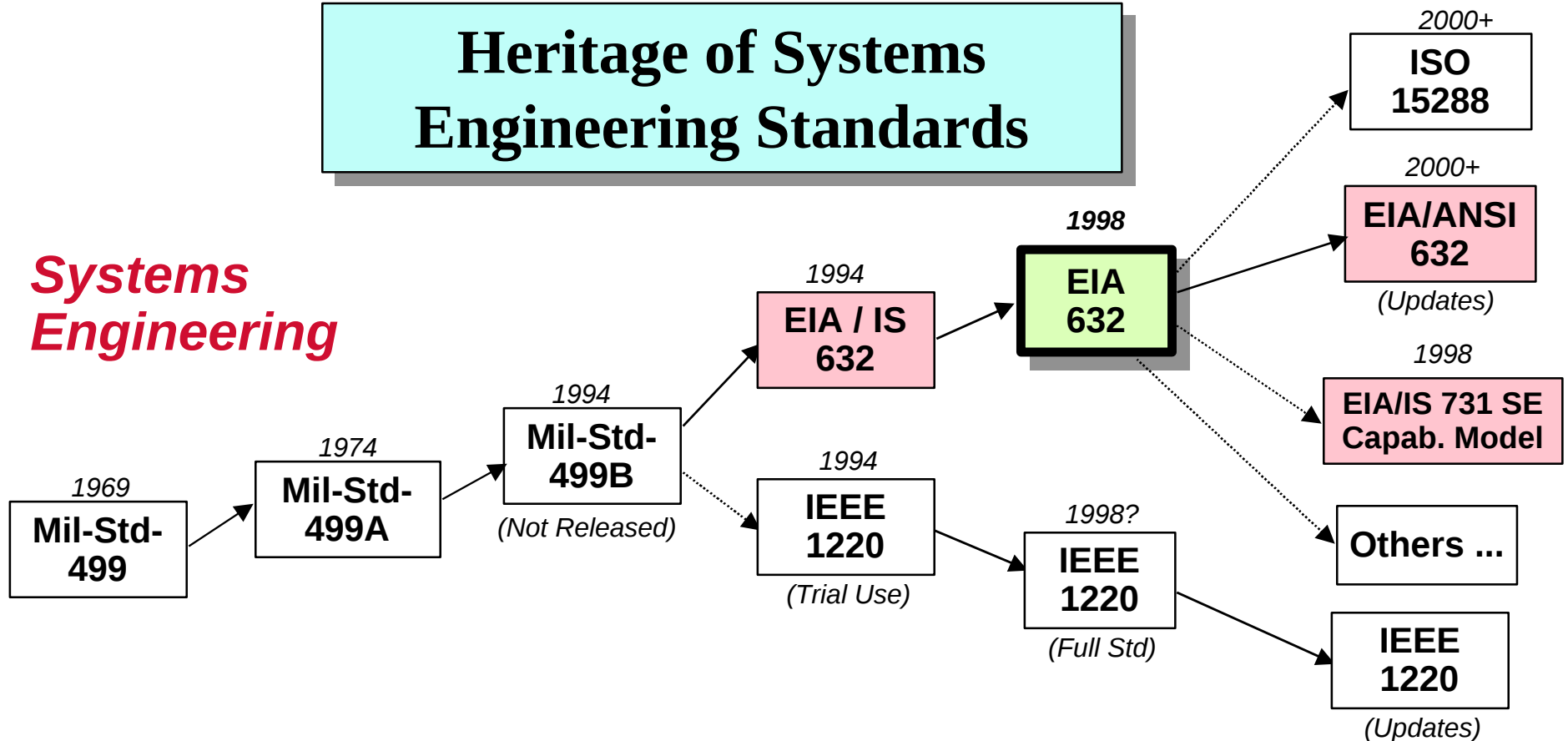


Evolution of EIA 632 from an Interim Standard to a Full Standard

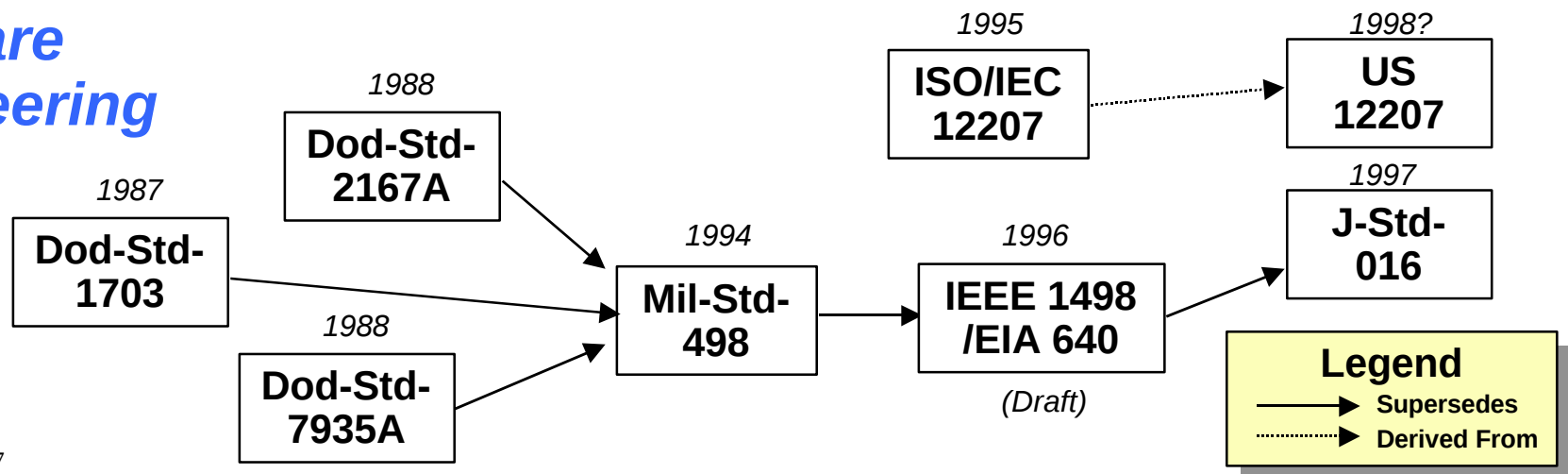
- ❖ **Heritage of this Standard**
- ❖ **Systems Engineering vs. “Engineering a System”**
- ❖ **Comparison between Old and New**
- ❖ **New Concepts**

Heritage of Systems Engineering Standards

Systems Engineering

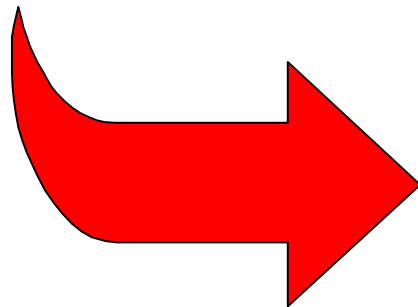
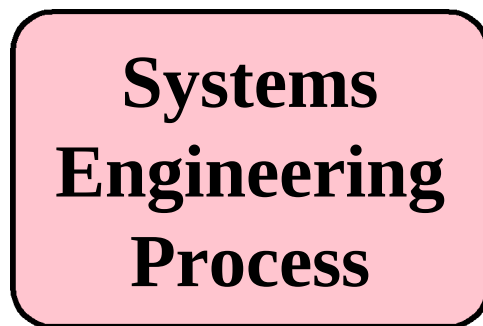


Software Engineering

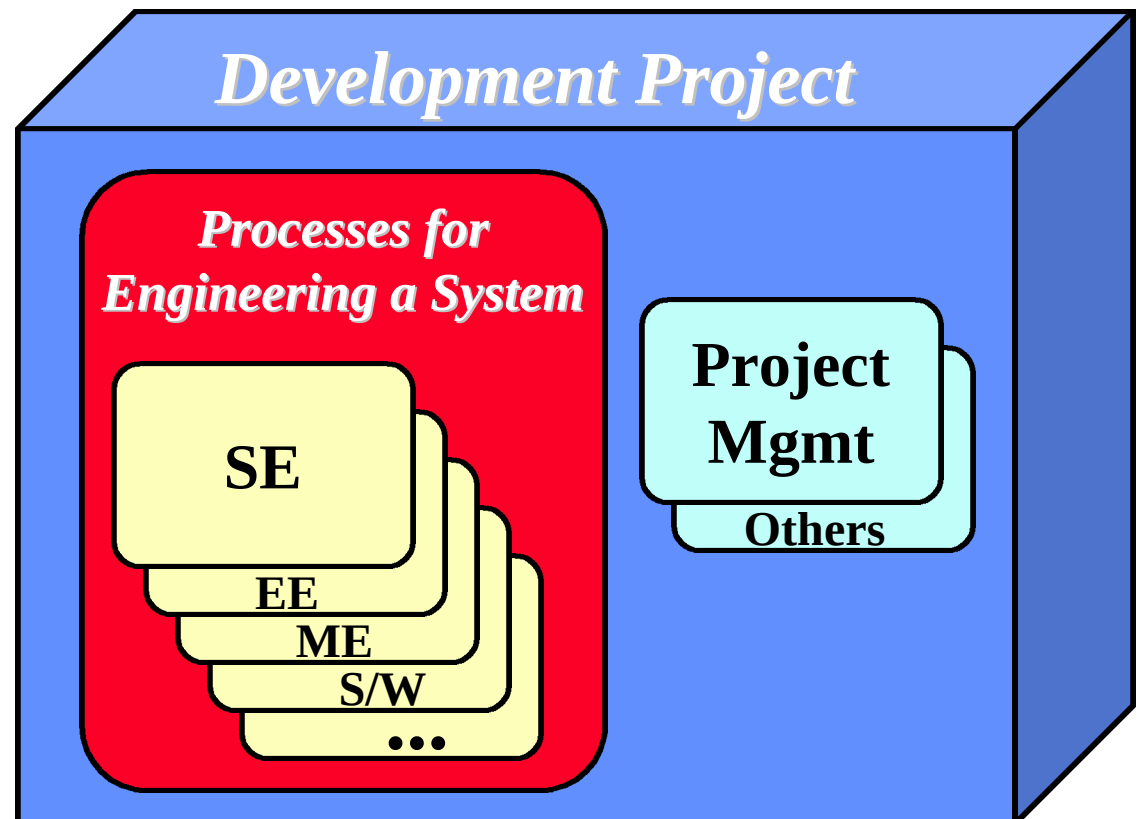


Systems Engineering vs. All Engineering

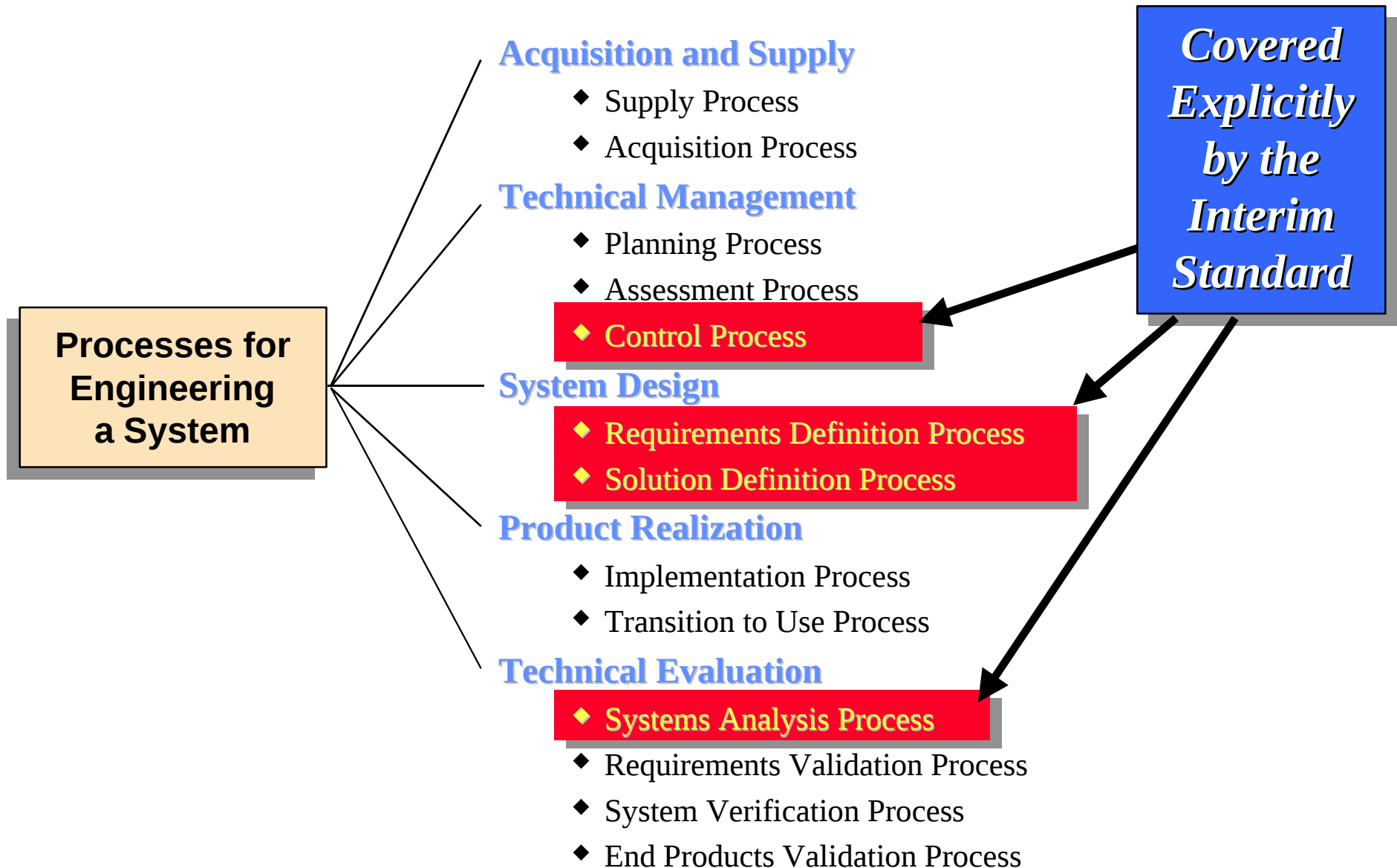
EIA 632
(Interim Standard)



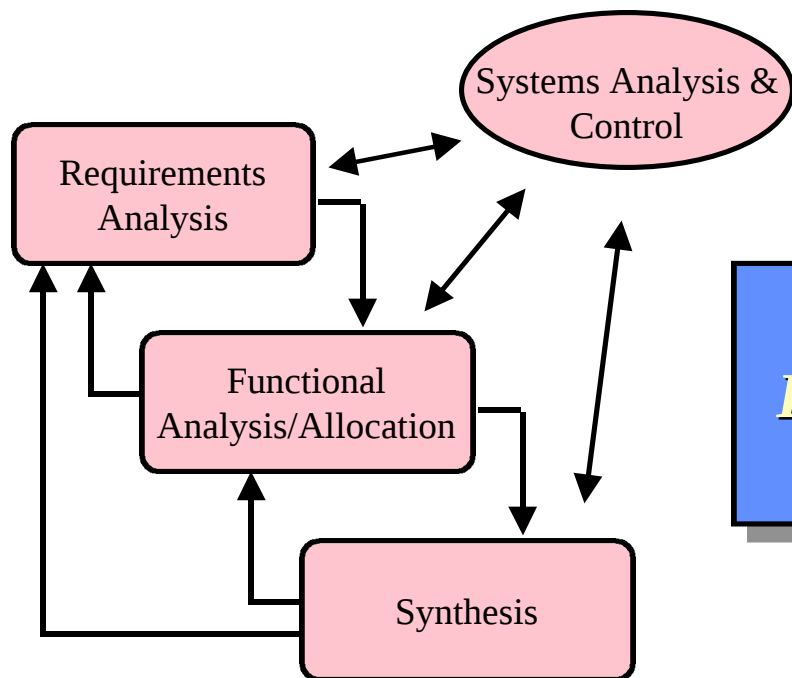
EIA 632
(Full Standard)



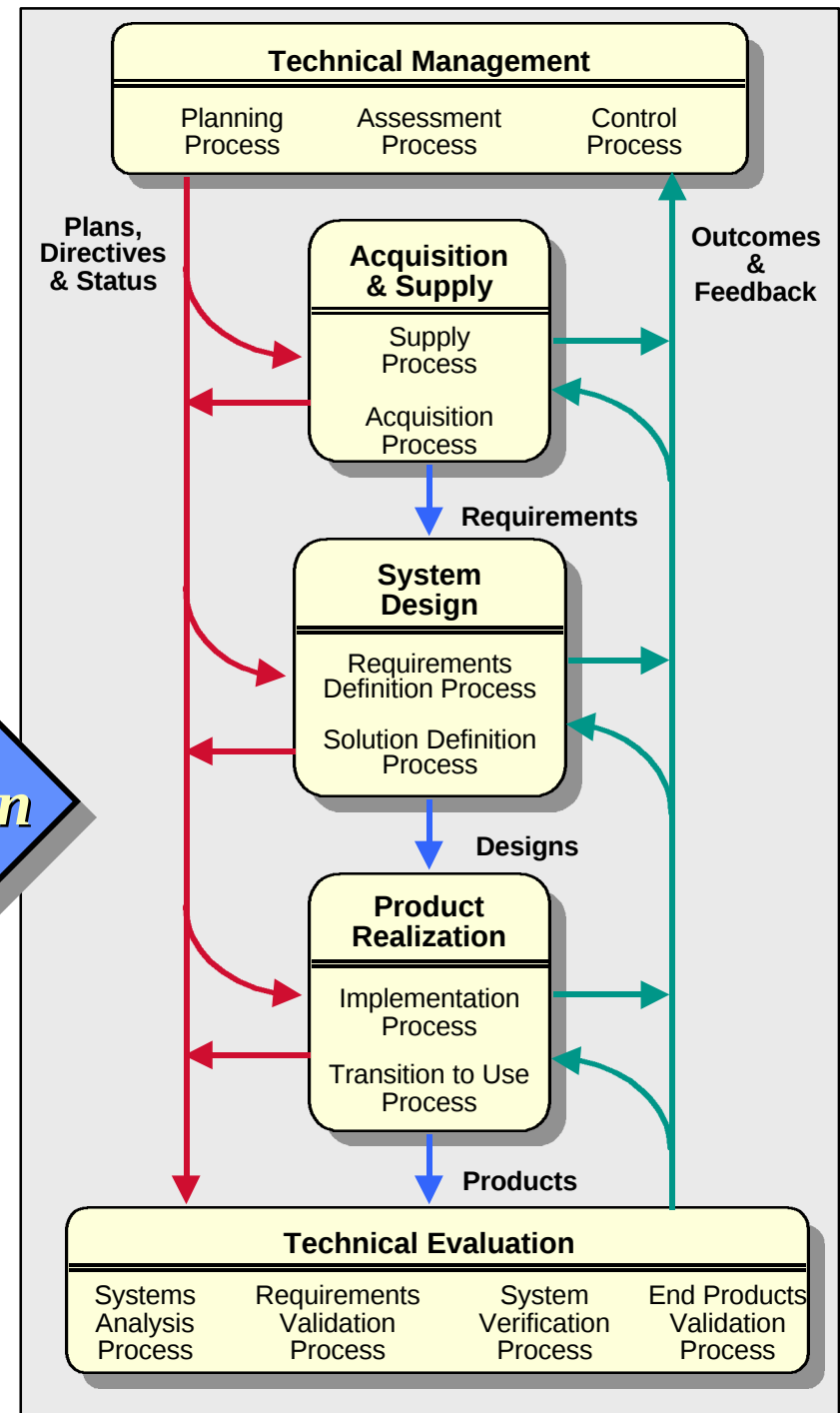
Comparison to Interim Standard Version



Evolution from Old to New

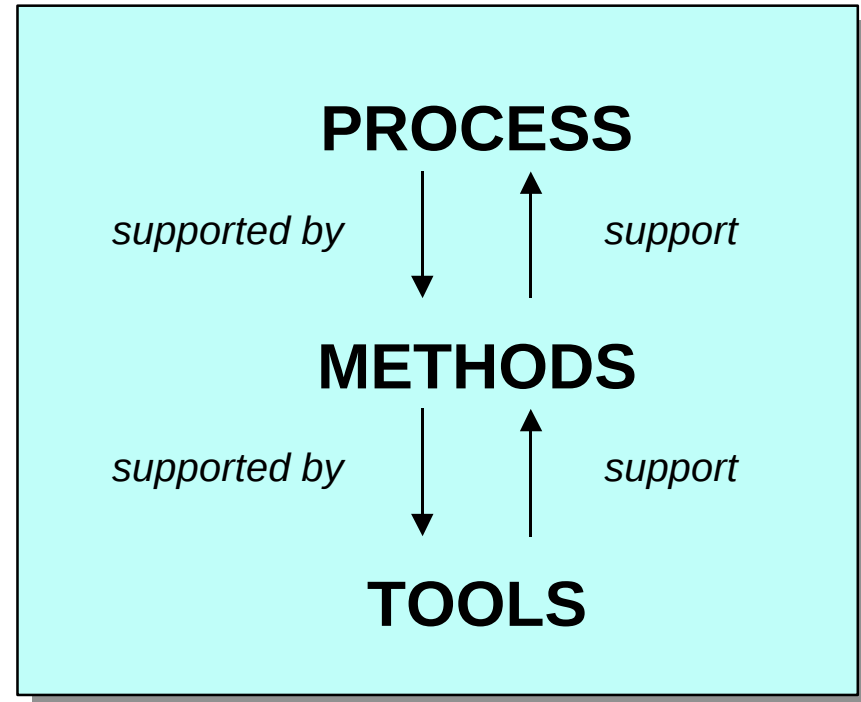


Evolution



Process vs. Methods

- **This standard does not specify Methods or Tools**
 - » Quality Function Deployment (QFD)
 - » Object-Oriented Analysis/Design
 - » Functional Analysis
 - » Finite State Machines
 - » etcetera
- **Left to the purview of 2nd-Tier Standards and Company Policy & Procedures**



New Concepts

- **System = HW + SW + Others**
- **System = End Products + Enabling Products**
- **Stakeholder Requirements**
- **Evolution of Requirements**
- **Emphasis on Validation**

Document Structure

**45
Pages**

- **Foreword**
- **Introduction**
- **Acknowledgments**
- **Scope**
- **Normative References**
- **Definitions & Acronyms**
- **Requirements**

38 Pages

- » Acquirer-Supplier
- » Technical Mgmt
- » System Design
- » Product Realization
- » Technical Evaluation

- **Application Context**
- **Application Key Concepts**
 - » Building Block
 - » System Structure
 - » Engineering Life Cycle
- **Annexes**
 - » Glossary
 - » Enterprise-Based Life Cycle
 - » Process Task Outcomes
 - » Planning Documents
 - » System Technical Reviews
 - » Unprecedented and Precedented Development
 - » Requirement Relationships
- **Index**

**70
Pages**

Process Hierarchy

Processes for Engineering a System

```
graph LR; A[Processes for Engineering a System] --- B[Acquisition and Supply (Subclause 4.1)]; A --- C[Technical Management (Subclause 4.2)]; A --- D[System Design (Subclause 4.3)]; A --- E[Product Realization (Subclause 4.4)]; A --- F[Technical Evaluation (Subclause 4.5)]; B --- B1[Supply Process]; B --- B2[Acquisition Process]; C --- C1[Planning Process]; C --- C2[Assessment Process]; C --- C3[Control Process]; D --- D1[Requirements Definition Process]; D --- D2[Solution Definition Process]; E --- E1[Implementation Process]; E --- E2[Transition to Use Process]; F --- F1[Systems Analysis Process]; F --- F2[Requirements Validation Process]; F --- F3[System Verification Process]; F --- F4[End Products Validation Process];
```

Acquisition and Supply (Subclause 4.1)

- ◆ Supply Process
- ◆ Acquisition Process

Technical Management (Subclause 4.2)

- ◆ Planning Process
- ◆ Assessment Process
- ◆ Control Process

System Design (Subclause 4.3)

- ◆ Requirements Definition Process
- ◆ Solution Definition Process

Product Realization (Subclause 4.4)

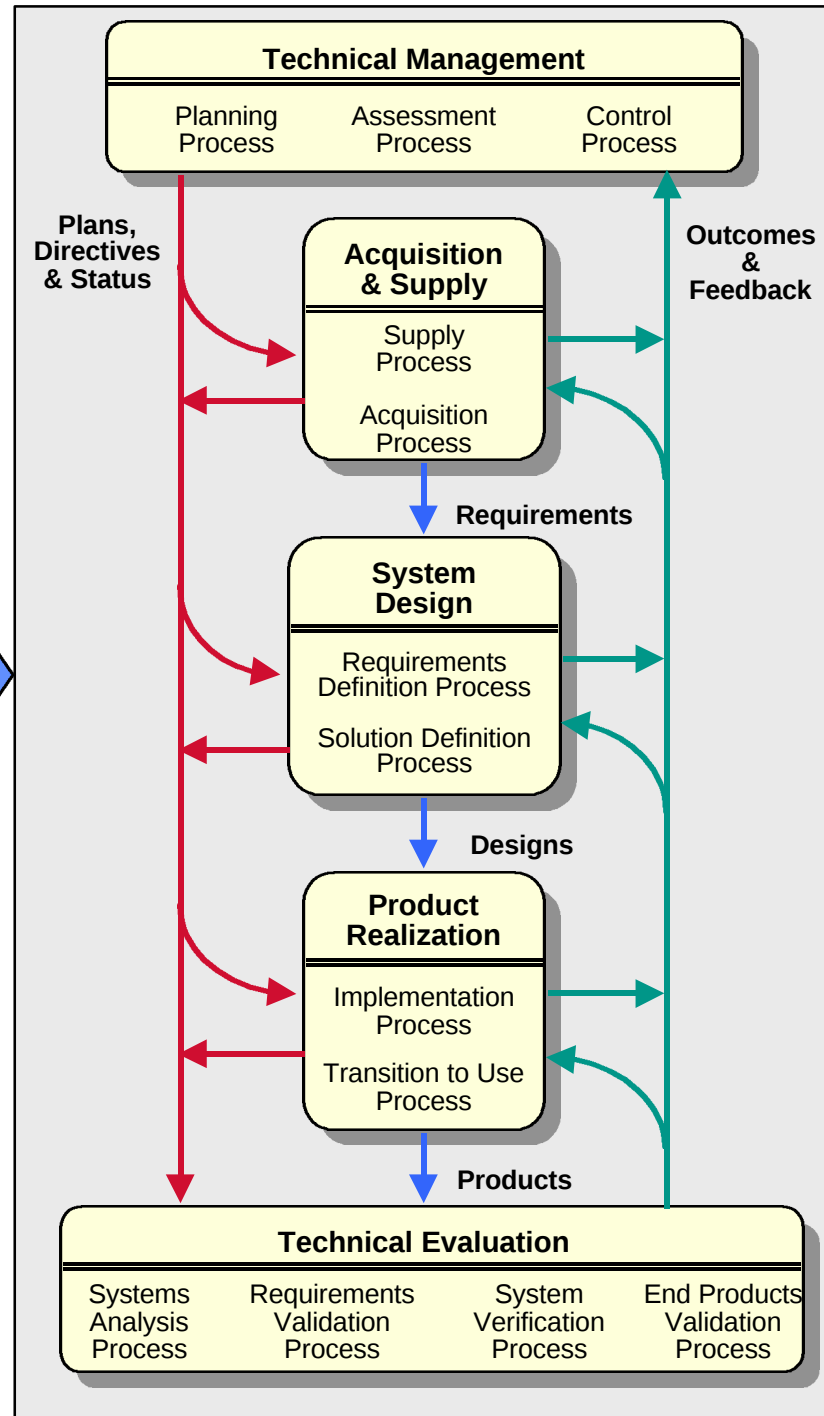
- ◆ Implementation Process
- ◆ Transition to Use Process

Technical Evaluation (Subclause 4.5)

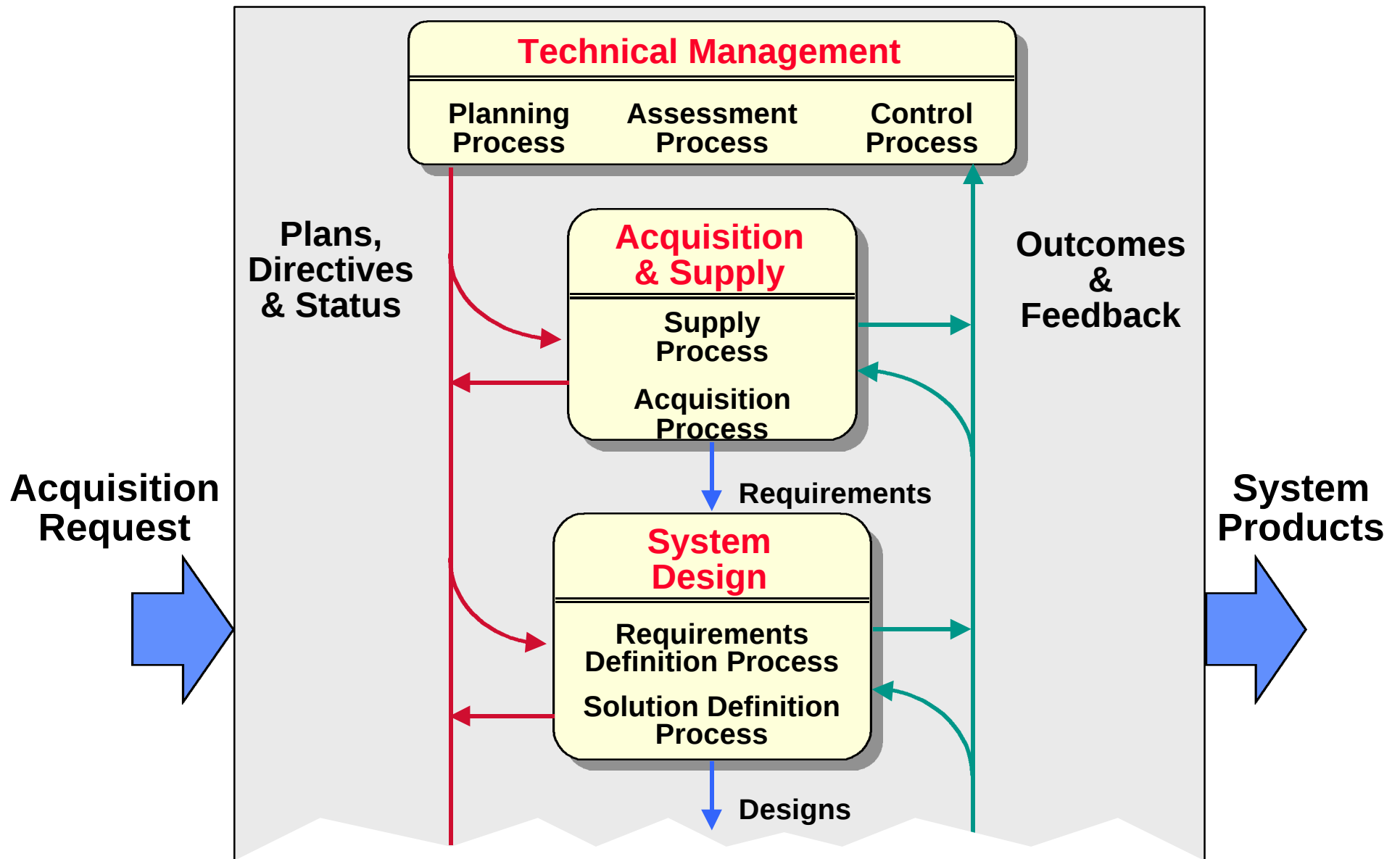
- ◆ Systems Analysis Process
- ◆ Requirements Validation Process
- ◆ System Verification Process
- ◆ End Products Validation Process

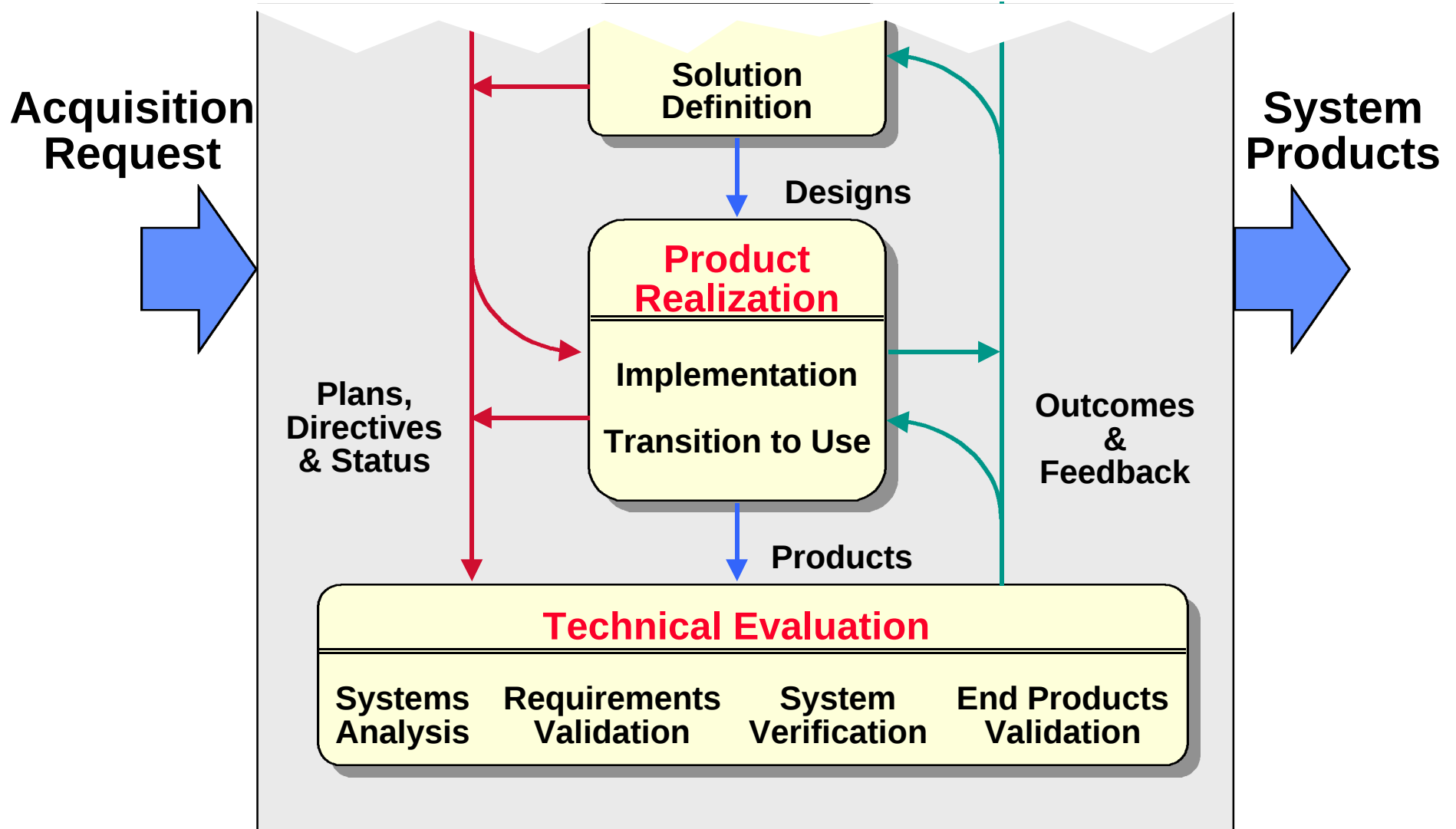
Top-Level Process Diagram

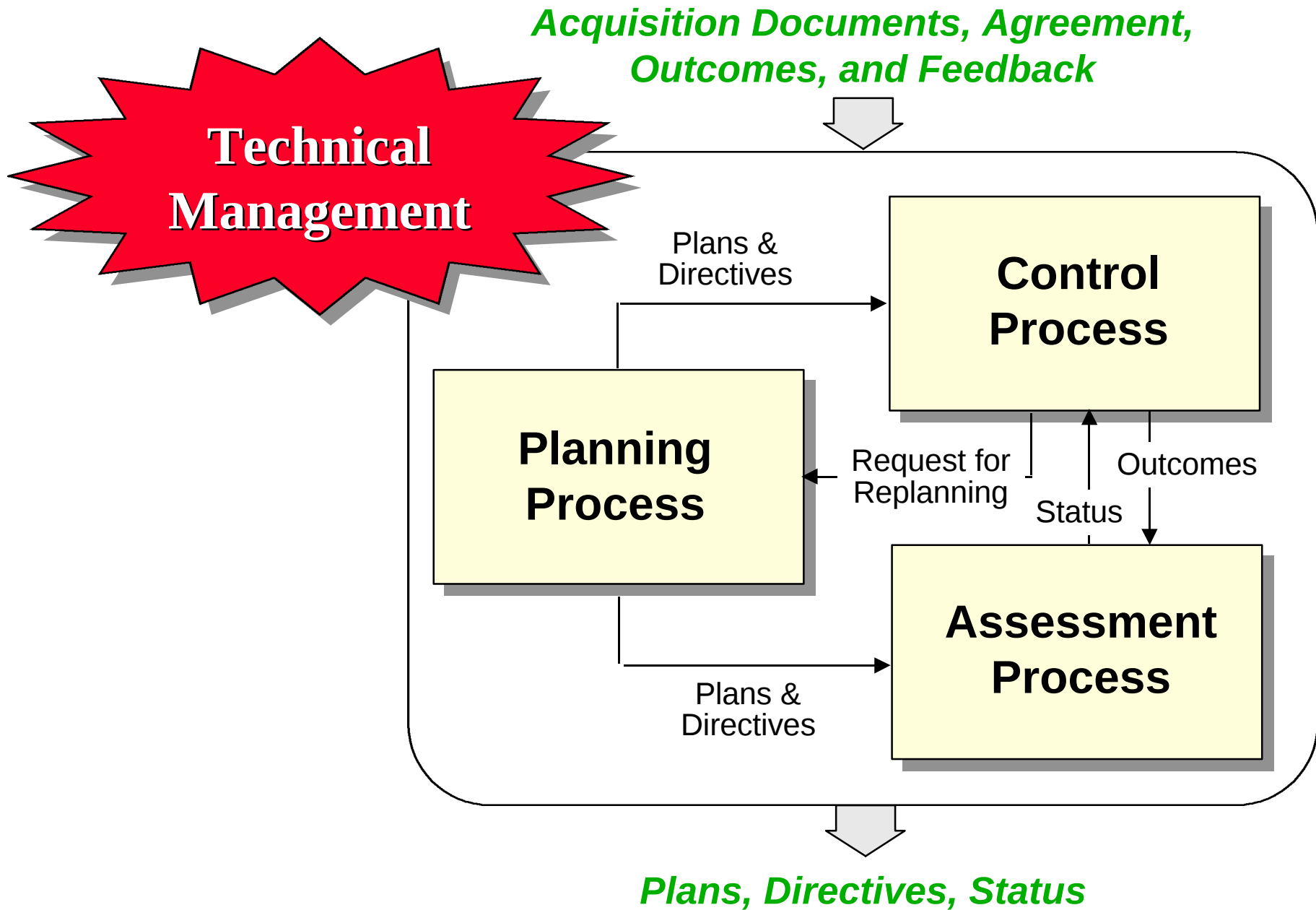
Acquisition Request



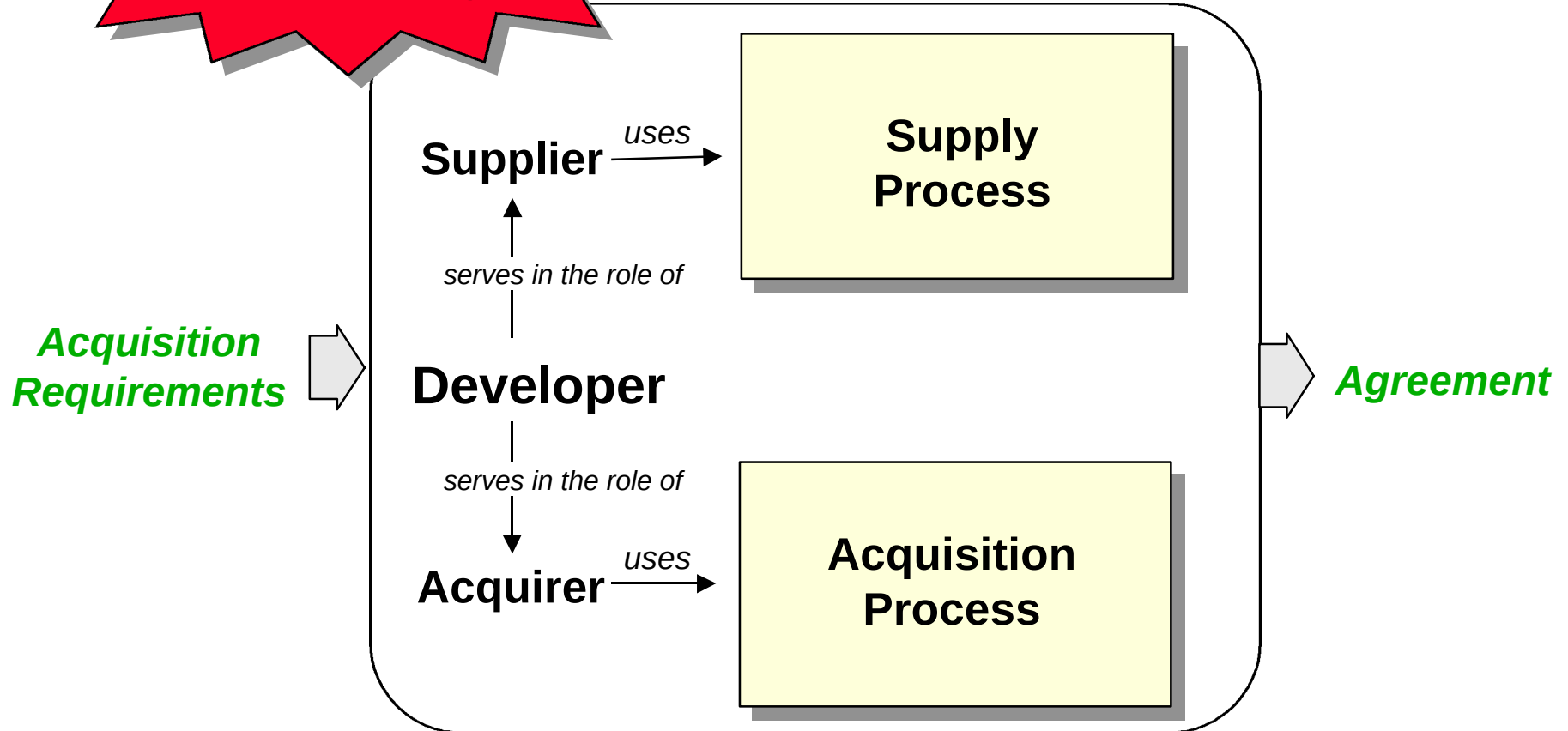
System Products

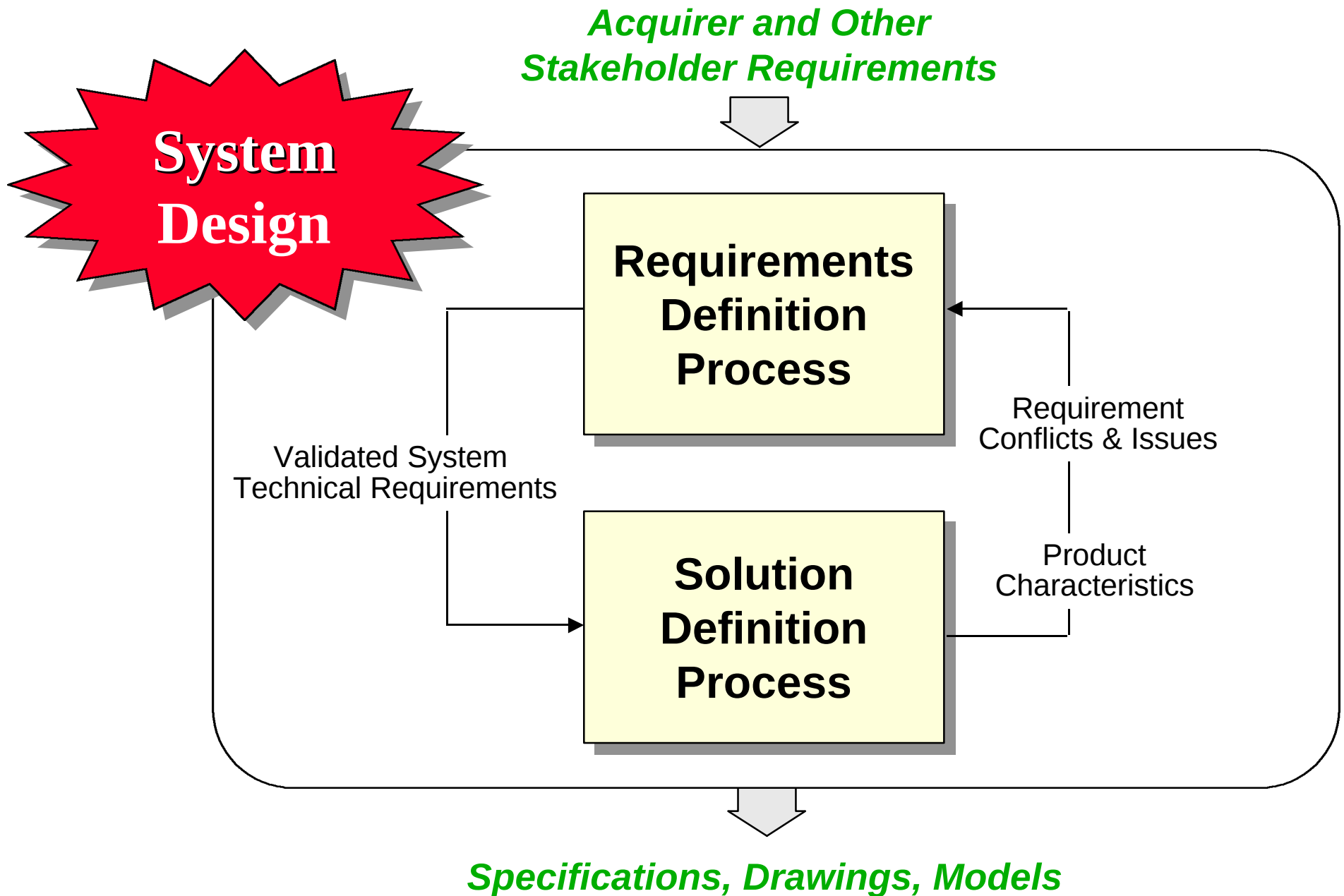




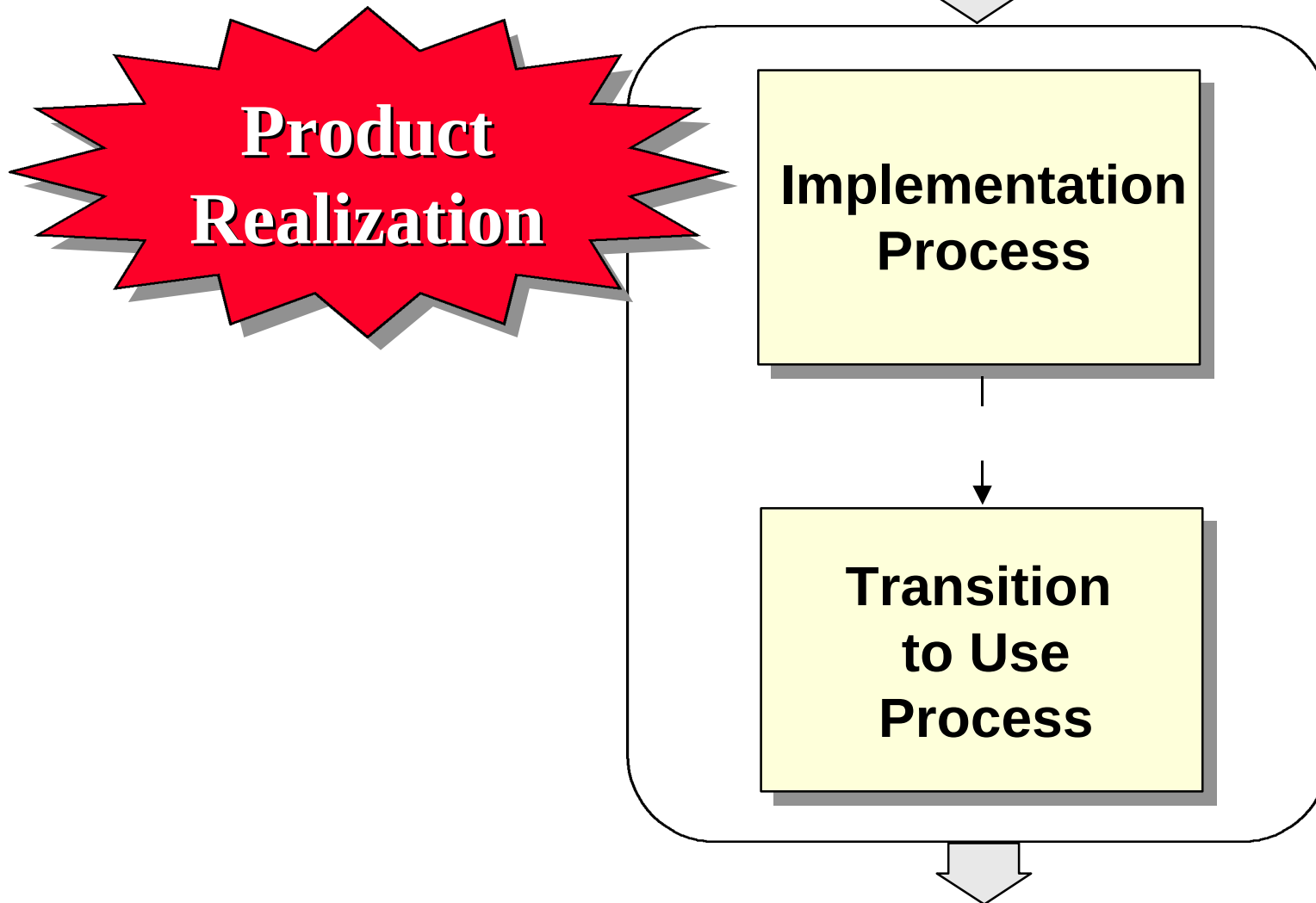


Acquisition & Supply





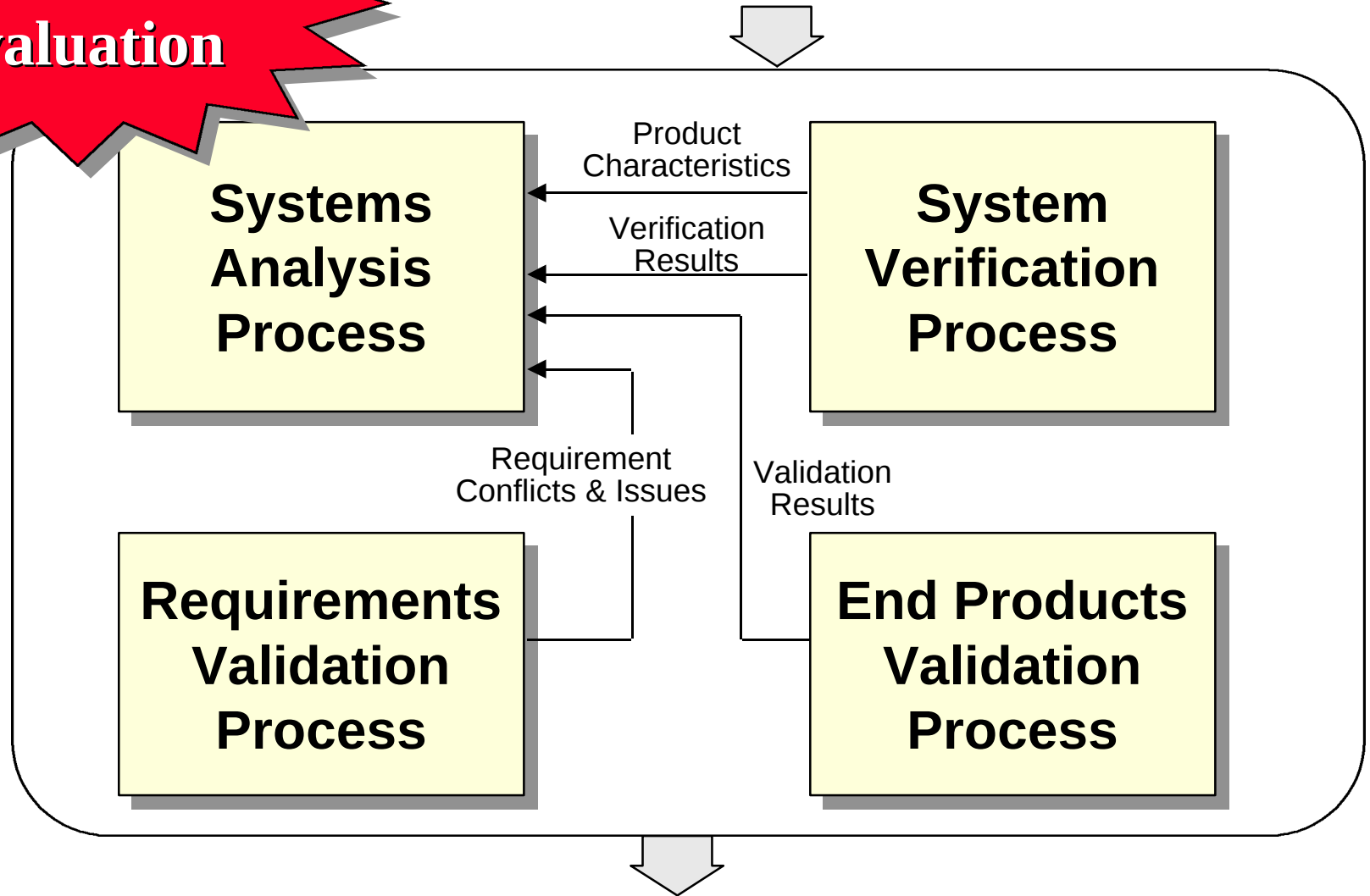
*Specified Requirements
Supplier- or Acquirer-Provided Products*



*Agreement Satisfaction
Other Stakeholder Satisfaction*

Technical Evaluation

*Analysis Requests, Requirements,
Implemented Products*



*Analytical Models & Assessments, Validated Requirements,
Verified Products, Validated Products*

SUPPLY PROCESS REQUIREMENTS

1—Product Supply

**ACQUISITION PROCESS
REQUIREMENTS**

2—Product Acquisition

3—Supplier Performance

**PLANNING PROCESS
REQUIREMENTS**

4—Process Implementation Strategy

5—Technical Effort Definition

6—Schedule and Organization

7—Technical Plans

8—Work Directives

**ASSESSMENT PROCESS
REQUIREMENTS**

9—Progress Against Plans and
Schedules

10—Progress Against Requirements

11—Technical Reviews

**CONTROL PROCESS
REQUIREMENTS**

12—Outcomes Management

13—Information Dissemination

**REQUIREMENTS DEFINITION
PROCESS REQUIREMENTS**

14—Acquirer Requirements

15—Other Stakeholder Requirements

16—System Technical Requirements

**SOLUTION DEFINITION PROCESS
REQUIREMENTS**

17—Logical Solution Representations

18—Physical Solution
Representations

19—Specified Requirements

**IMPLEMENTATION PROCESS
REQUIREMENTS**

20—Implementation

**TRANSITION TO USE PROCESS
REQUIREMENTS**

21—Transition to Use

**SYSTEMS ANALYSIS PROCESS
REQUIREMENTS**

22—Effectiveness Analysis

23—Tradeoff Analysis

24—Risk Analysis

**REQUIREMENTS VALIDATION
PROCESS REQUIREMENTS**

25—Statements Validation

26—Acquirer Requirements
Validation

27—Other Stakeholder Requirements
Validation

28—System Technical Requirements
Validation

29—Logical Solution Representations
Validation

**SYSTEM VERIFICATION PROCESS
REQUIREMENTS**

30—Design Solution Verification

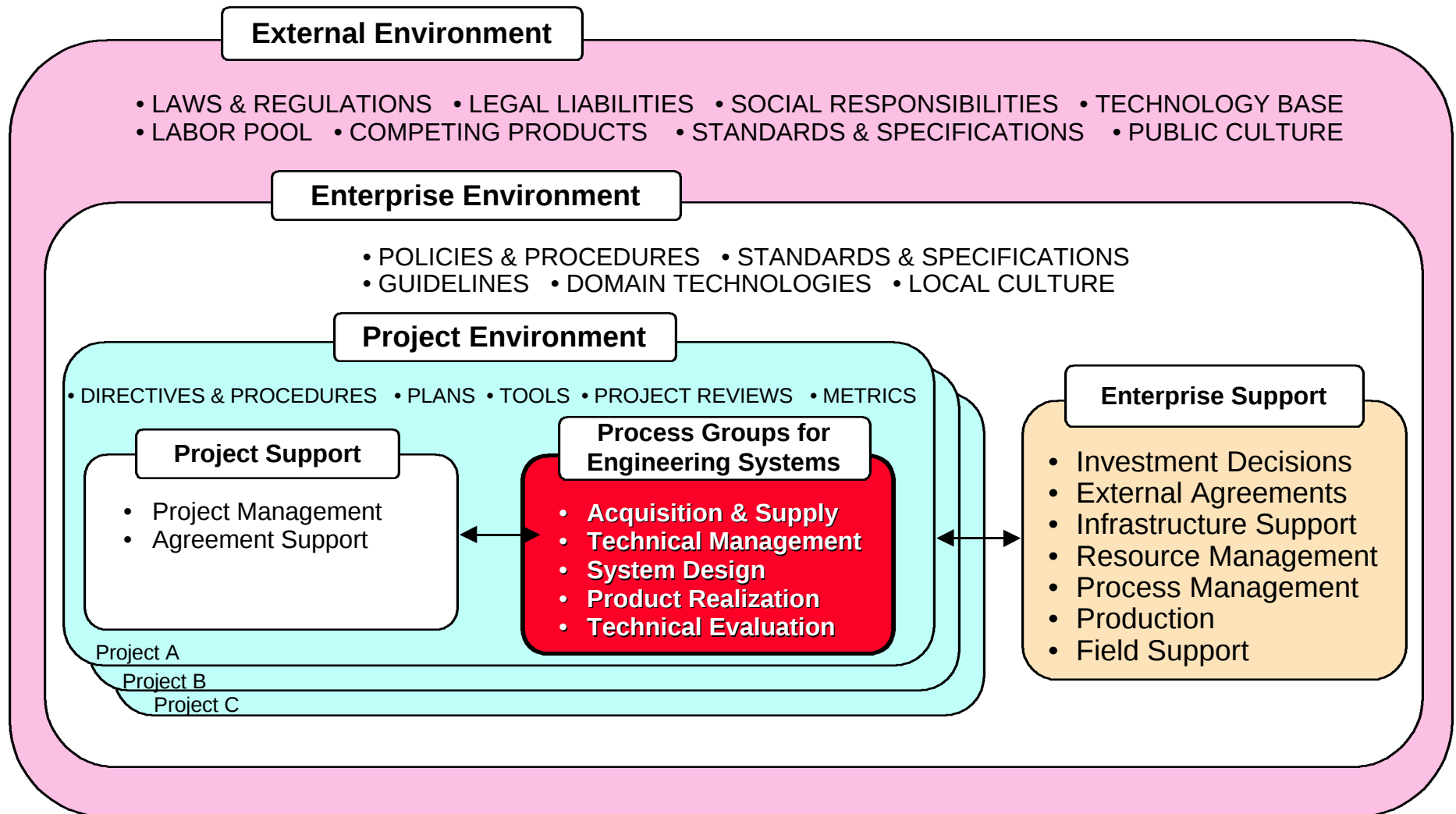
31—End Product Verification

32—Enabling Product Readiness

**END PRODUCTS VALIDATION
PROCESS REQUIREMENTS**

33—End Products Validation

Project Environment

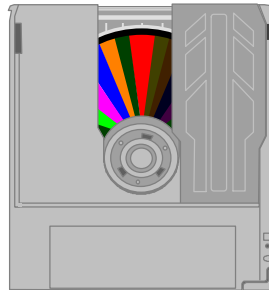
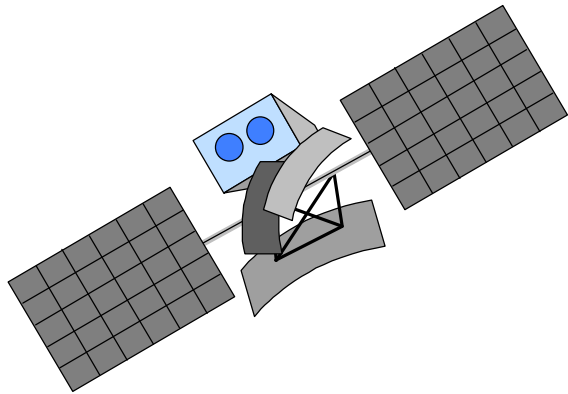


Key Concepts

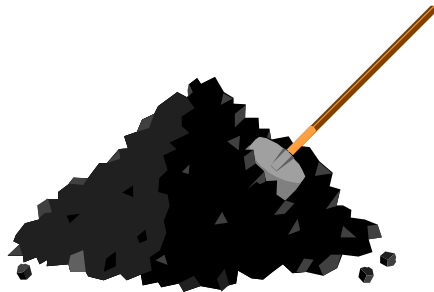
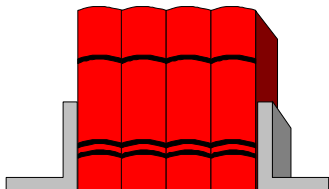
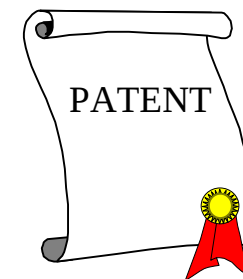
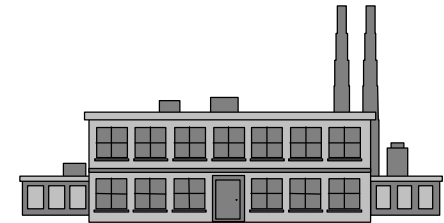
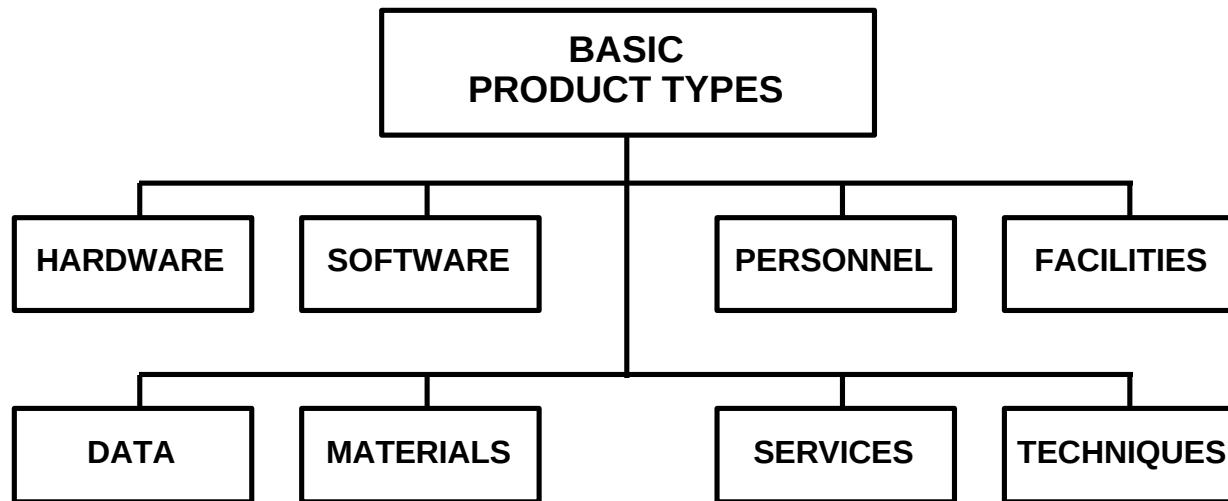
- **What is a Product?**
- **What is a System?**
- **Building Block**
- **Development Layers**

What Types of Products Constitute a System?

- Hardware and Software ??
- Hardware and Software and People ??



Basic Product Types

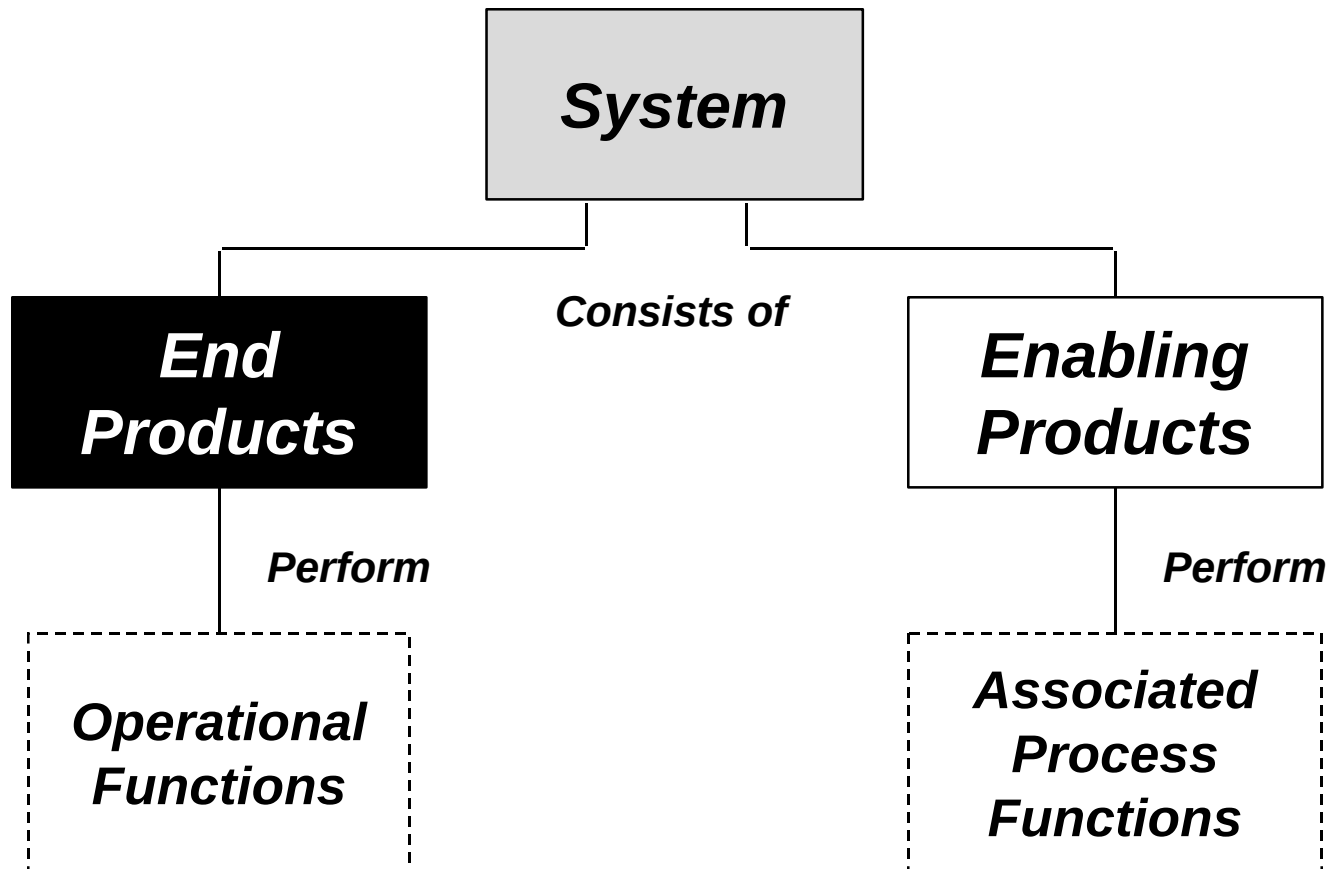


Other Possible Product Types (Needing Development or Acquisition)

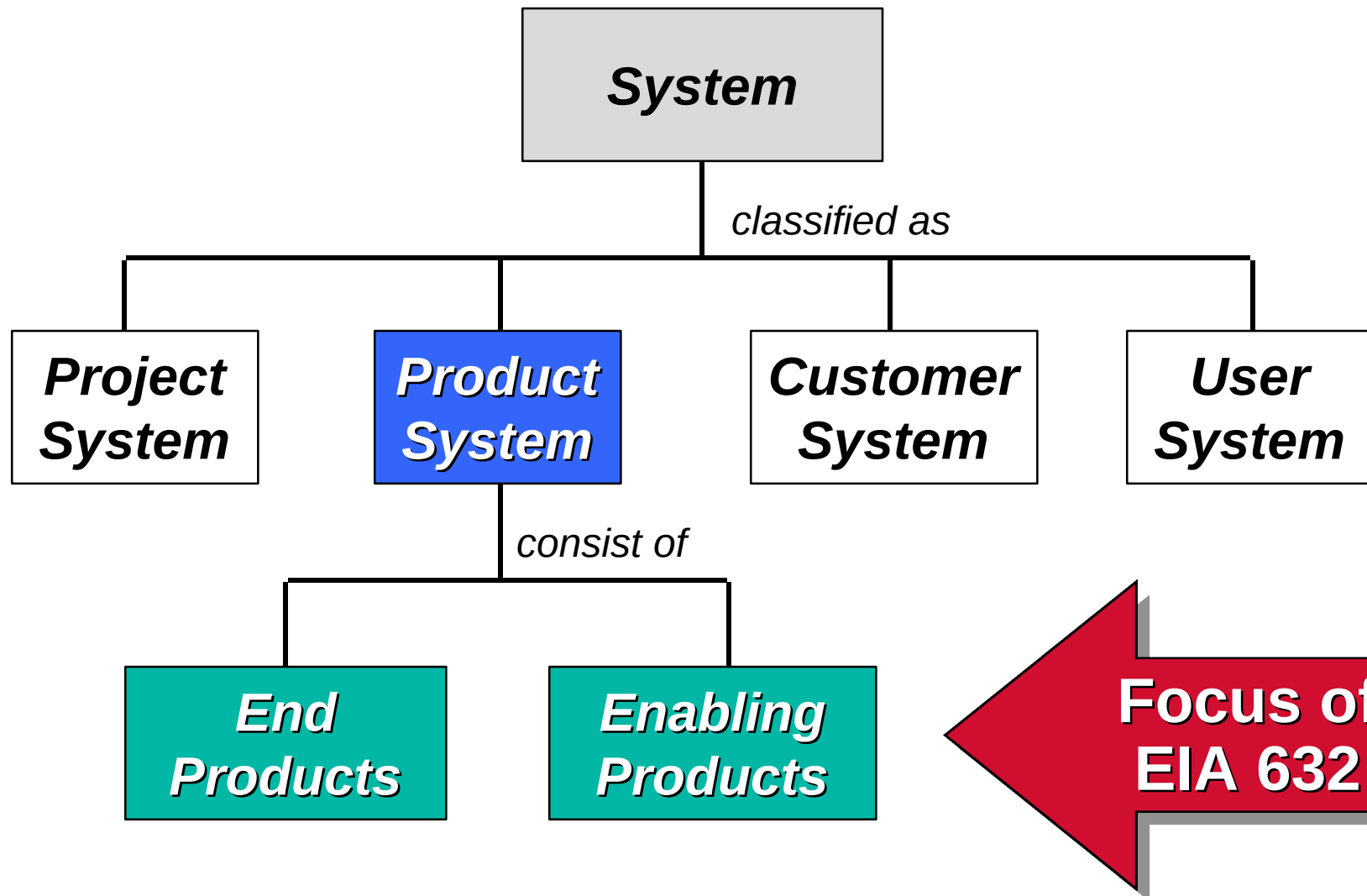
- Media
- Documents
- Procedures
- Information
- Ships
- Structures (e.g., Bridges, Oil Derricks)
- . . .

*. . . Whatever is necessary for your
application domain*

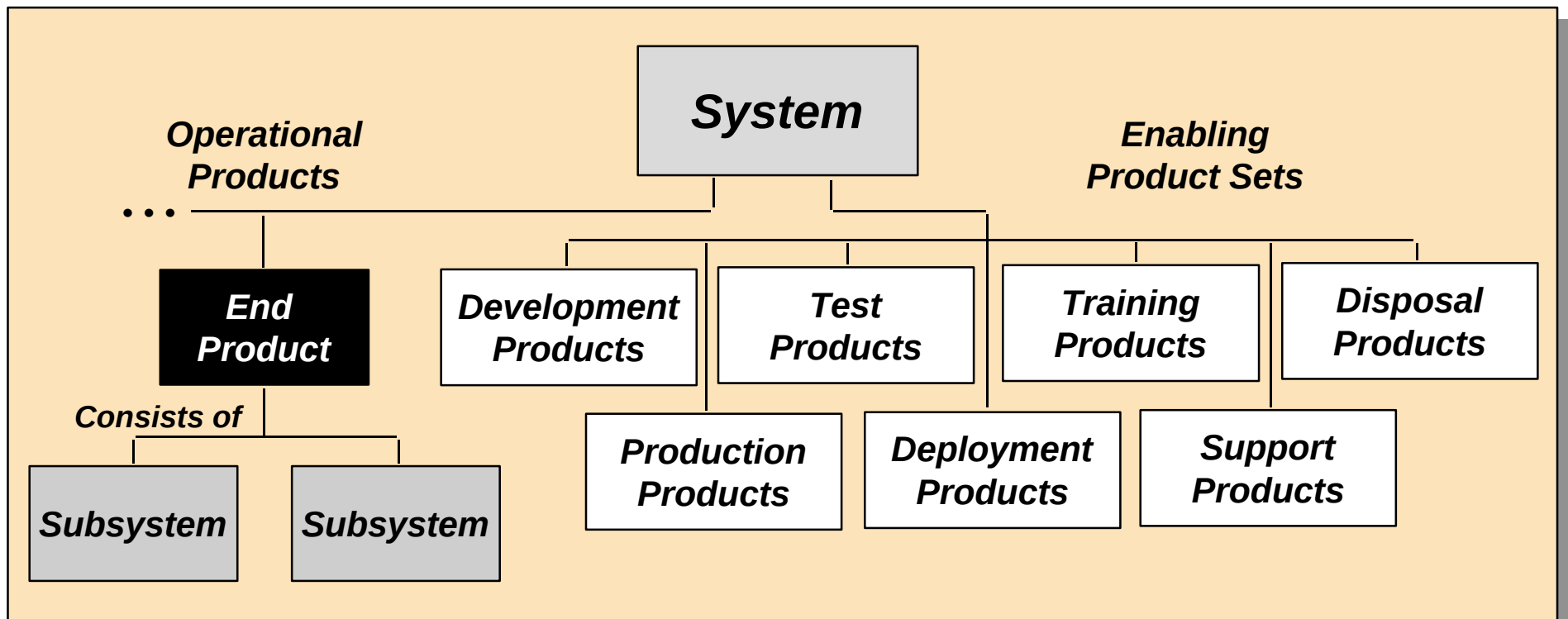
What is a System?



Types of Systems

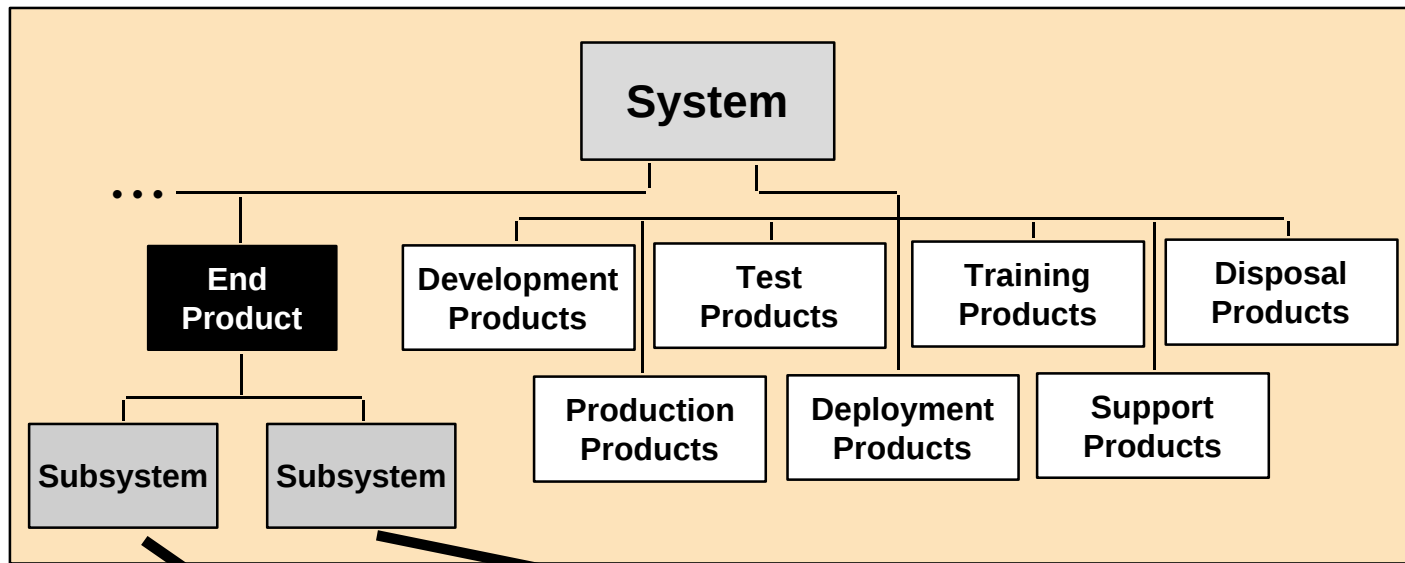


The Building Block Concept

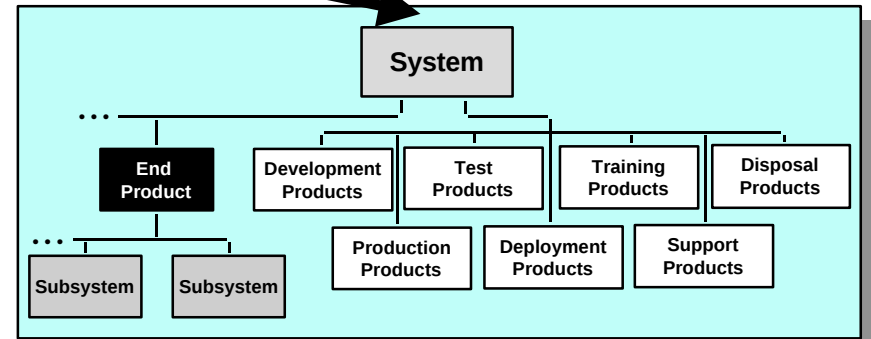
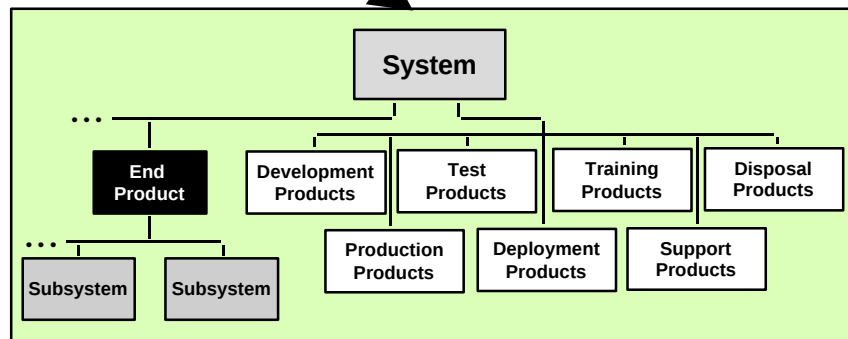


Development Layers Concept

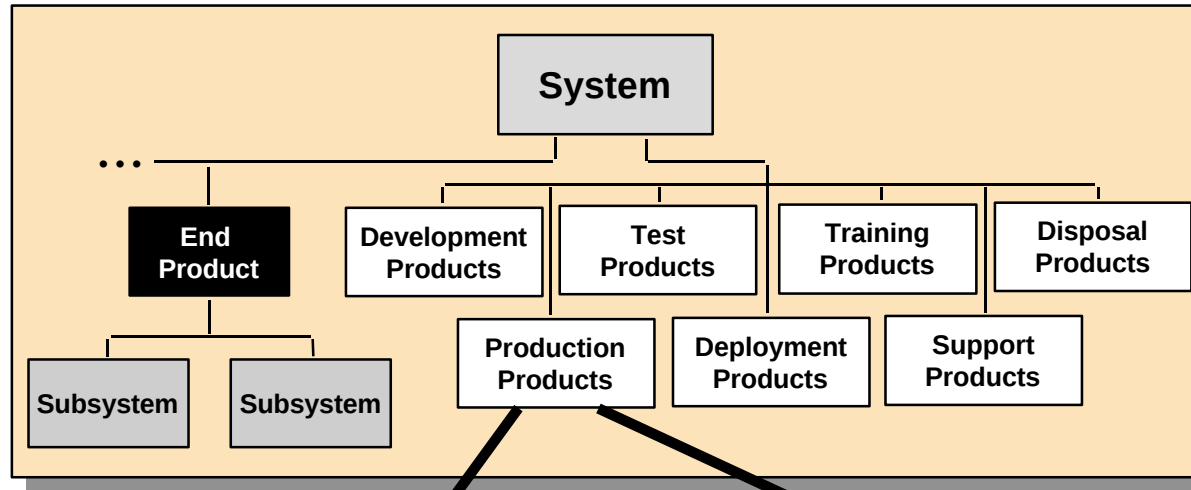
Layer N Building Block



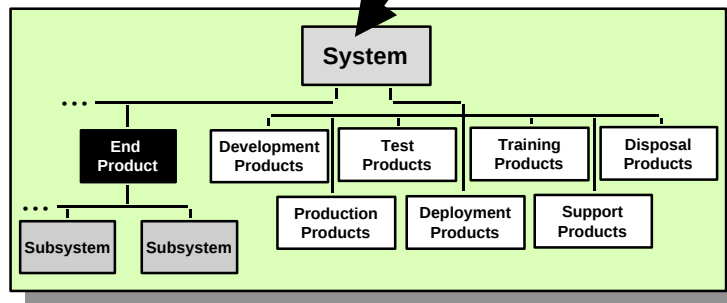
Layer N+1 Building Blocks



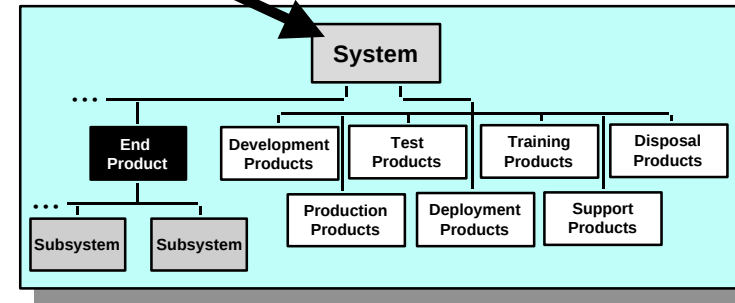
Development of “Enabling Products”



Example: Production Equipment



Example: Production Facilities

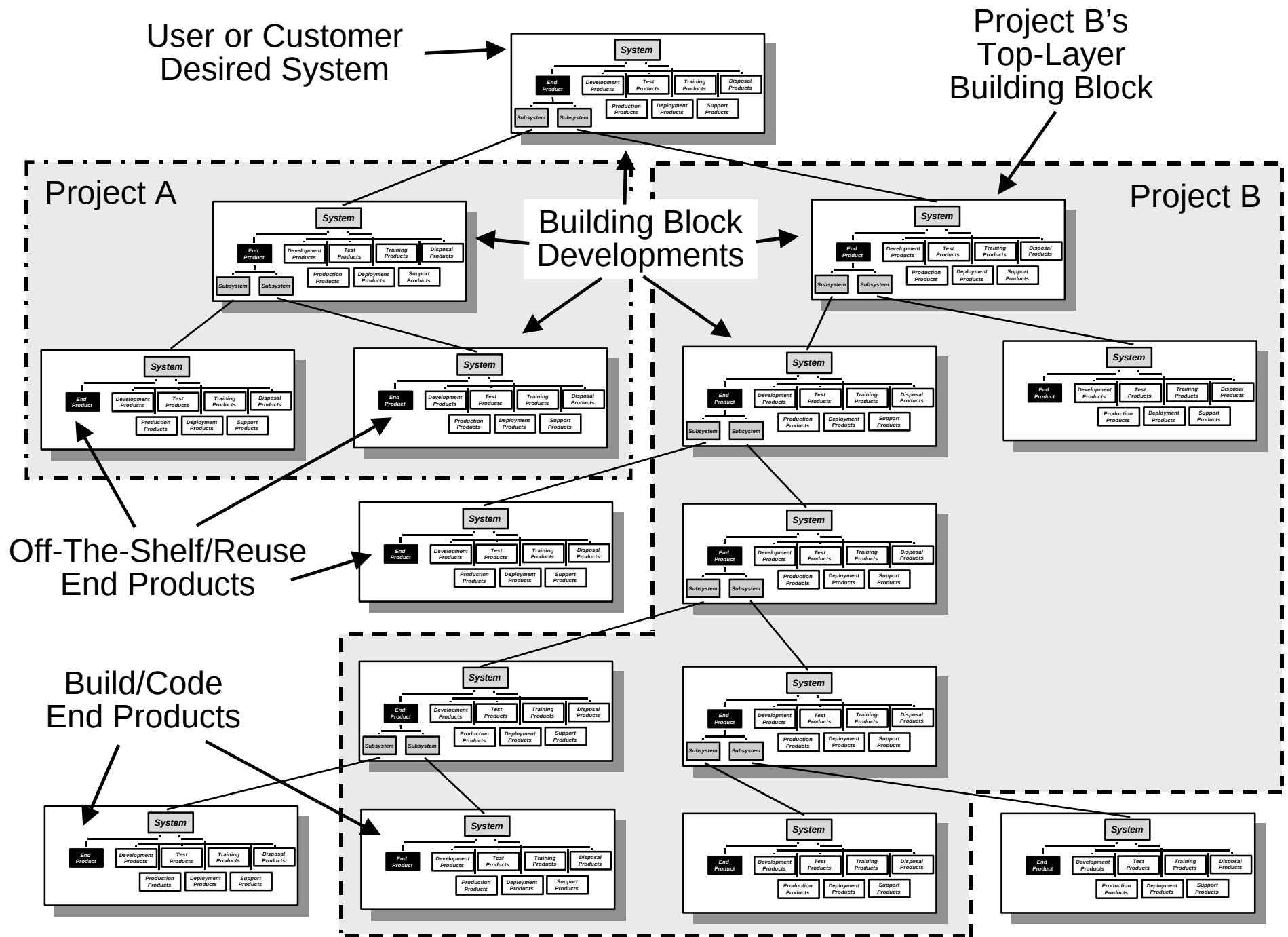


Other Production Enabling Products Possibly Needing Development:

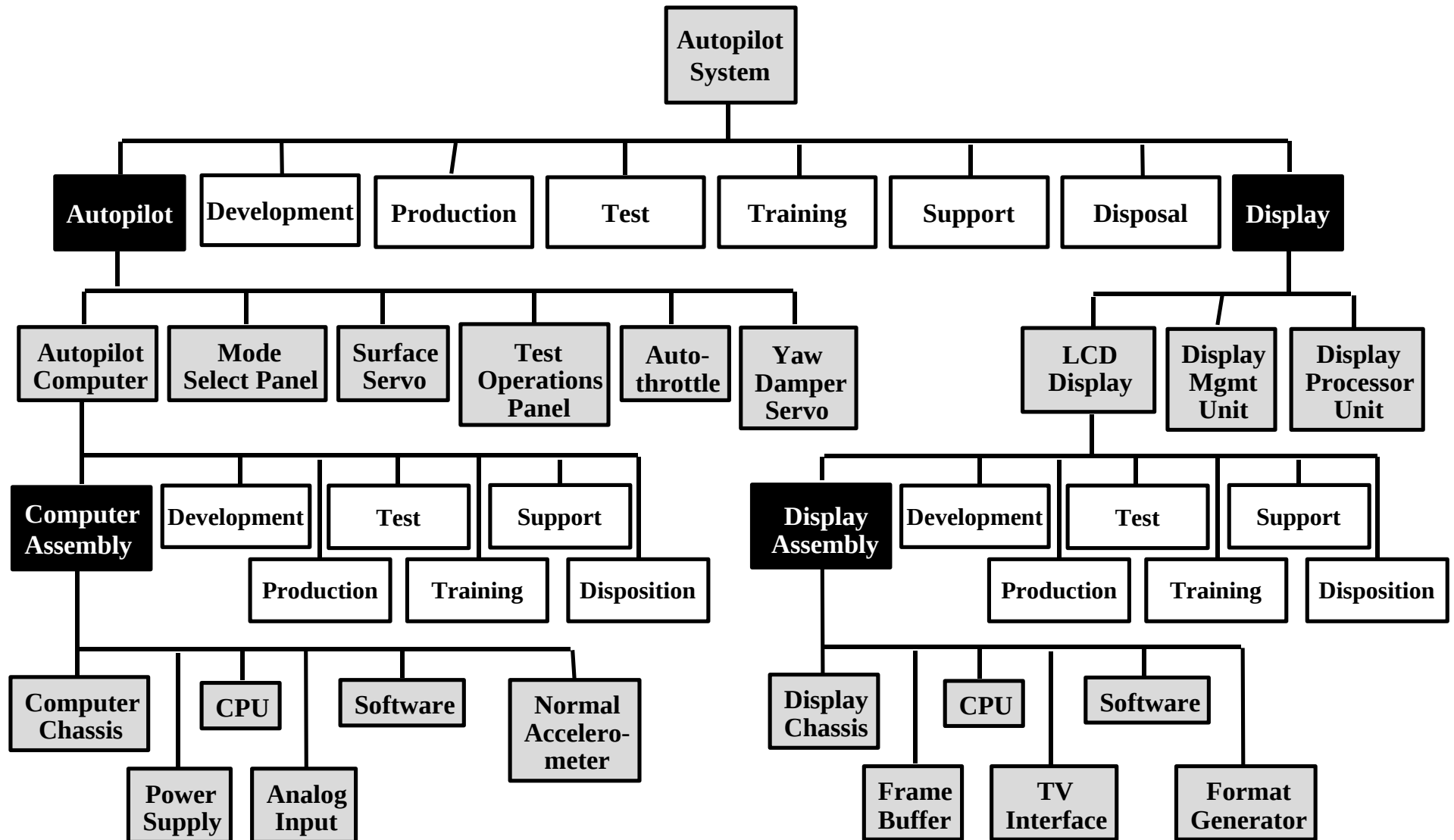
- ⌘ Manufacturing Procedures (e.g. soldering, jigging)
- ⌘ Manufacturing Personnel (e.g. test operators, assembly technicians)
- ⌘ Manufacturing Services (e.g. shipping & receiving, JIT deliveries)

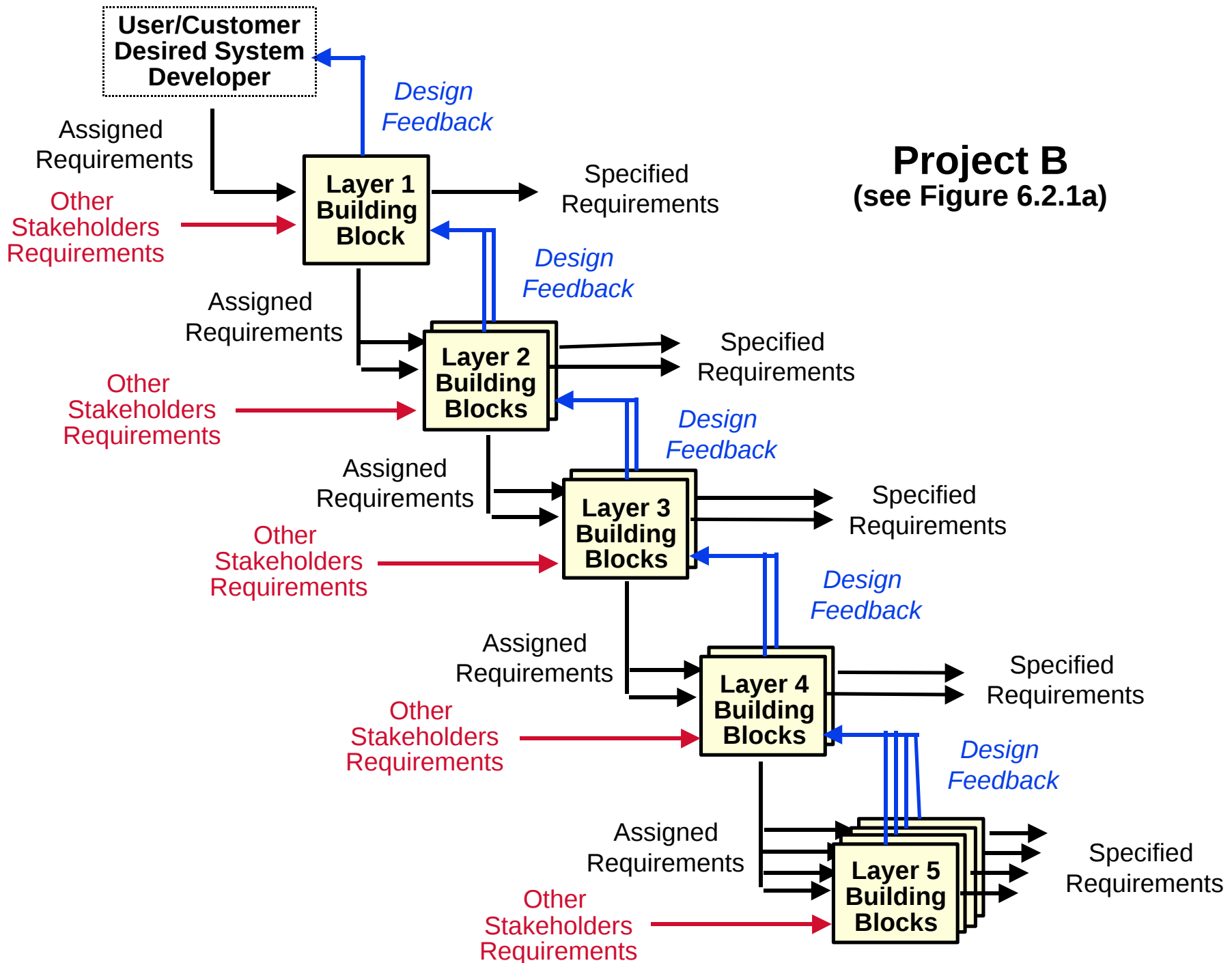
Example Enabling Products

- **Development**
 - » Development Plans and Schedules
 - » Engineering Policies and Procedures
 - » CAE Tools
 - » Prototypes
 - » Engineers and Managers
- **Production**
 - » Production Plans and Schedules
 - » Production Tooling and Facilities
- **Test**
 - » Test Equipment and Software
 - » Test Plans and Procedures
- **Deployment**
 - » Staging facilities
 - » Warehouses
 - » Shipping Containers
- **Training**
 - » Class Rooms
 - » Flight Simulator
 - » Instructors
- **Support**
 - » Customer Hot Line
 - » Repair Facilities
 - » Diagnostic Equipment
 - » Overnight Shipping Service
- **Disposal**
 - » Disposal Site
 - » Refurbishment Facilities
 - » Removal Tools
 - » Public Safety Bulletins

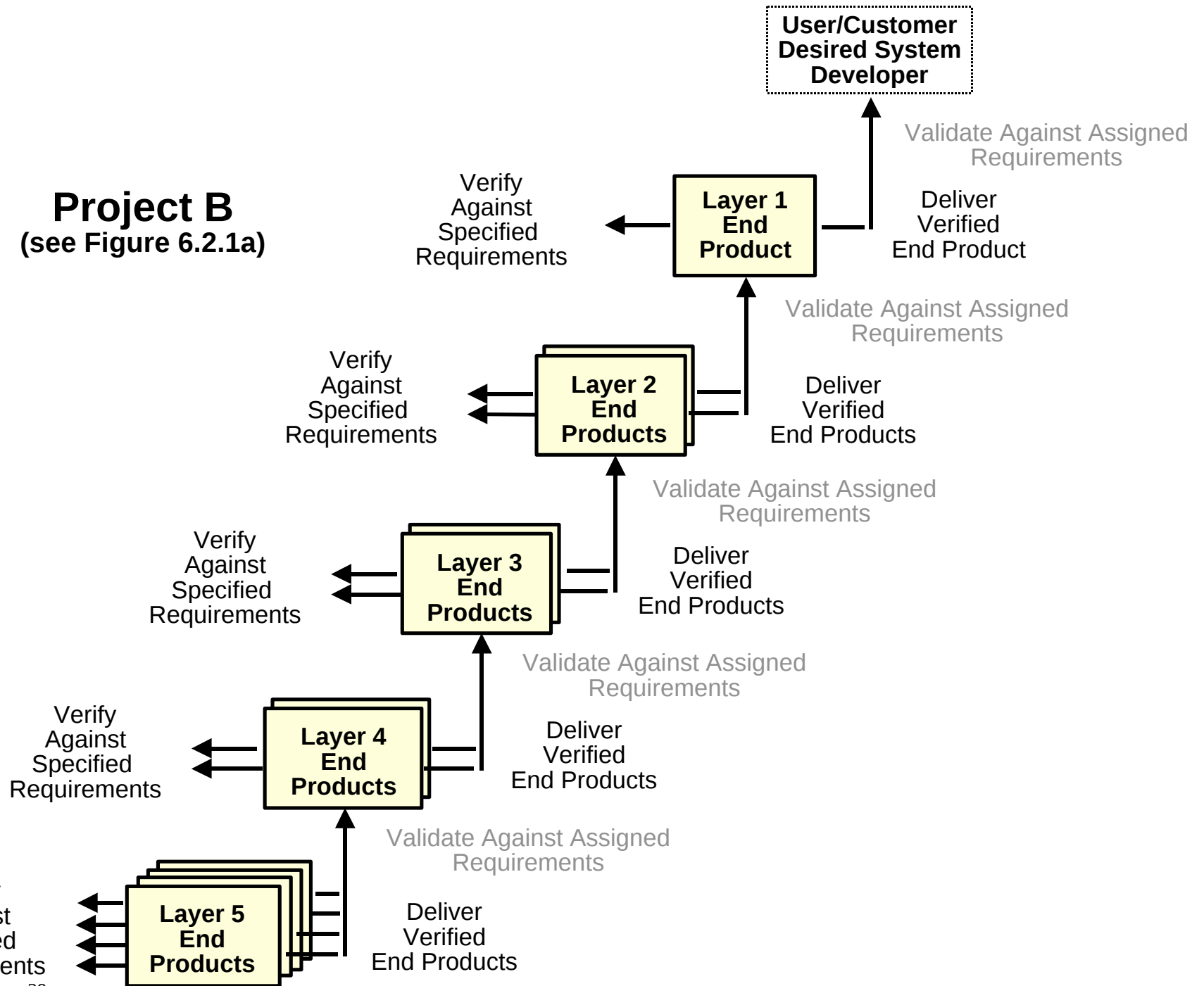


Example Building Block Hierarchy

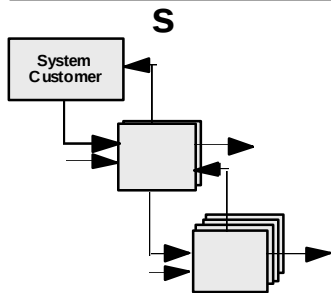




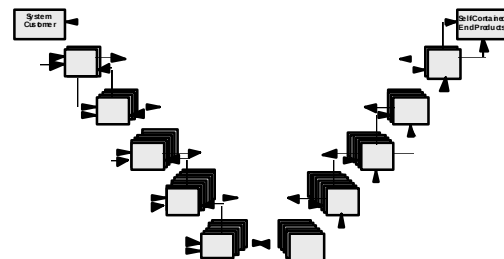
Project B
(see Figure 6.2.1a)



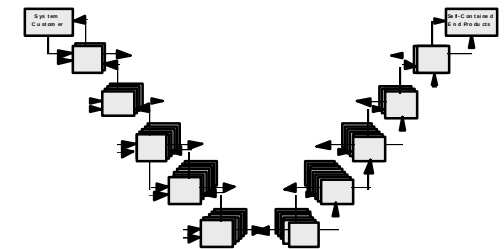
Assessment of Opportunities	Investment Decision	System Concept Development	Subsystem Design & Pre-Deployment	Deployment/ Installation, Operations & Support
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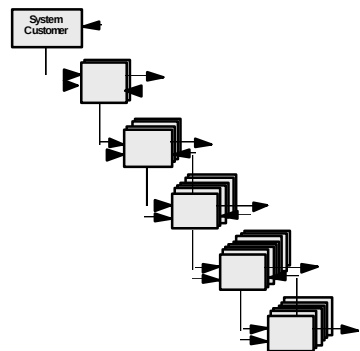
Simulation



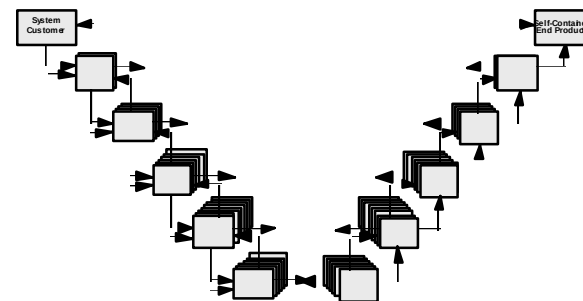
Advanced Technology Prototype



Improvements, As Necessary



Simulation, Physical or Functional Prototype

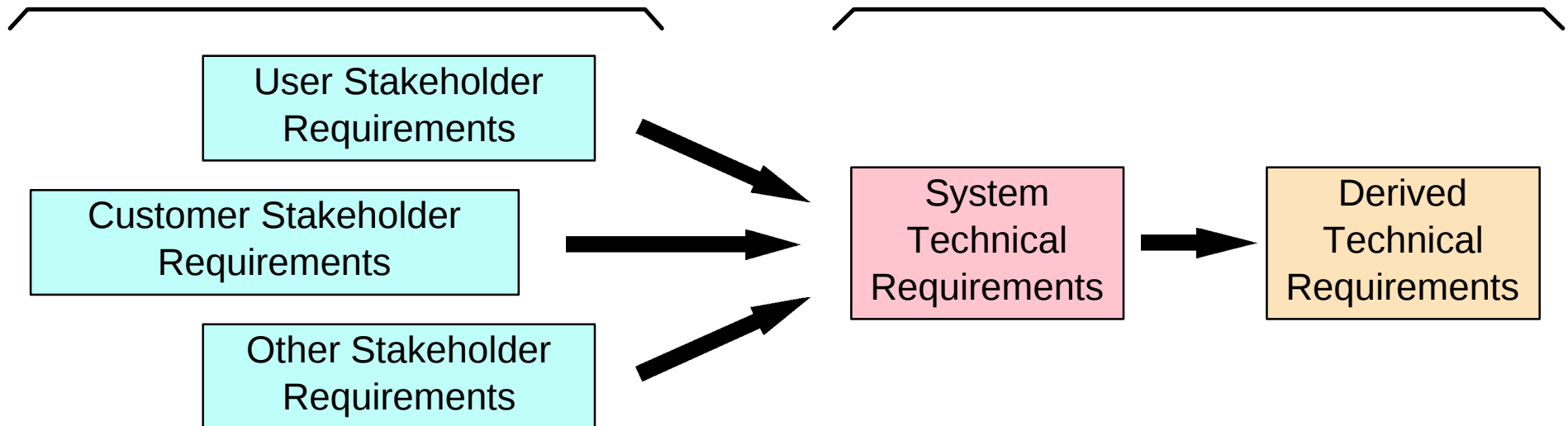


Pre-Production Prototype, Production Runs

Evolution of Requirements

Stakeholder Requirements

Technical Requirements



Types of Requirements

- **Functional Requirements**

- » *What* an item is to accomplish

- Behavior of an item
- An effect produced
- Action or service to be performed

- **Performance Requirements**

- » *How well* an item is to accomplish a function

- ... like how much, how often, how many, how few, . . .

- **Interface Requirements**

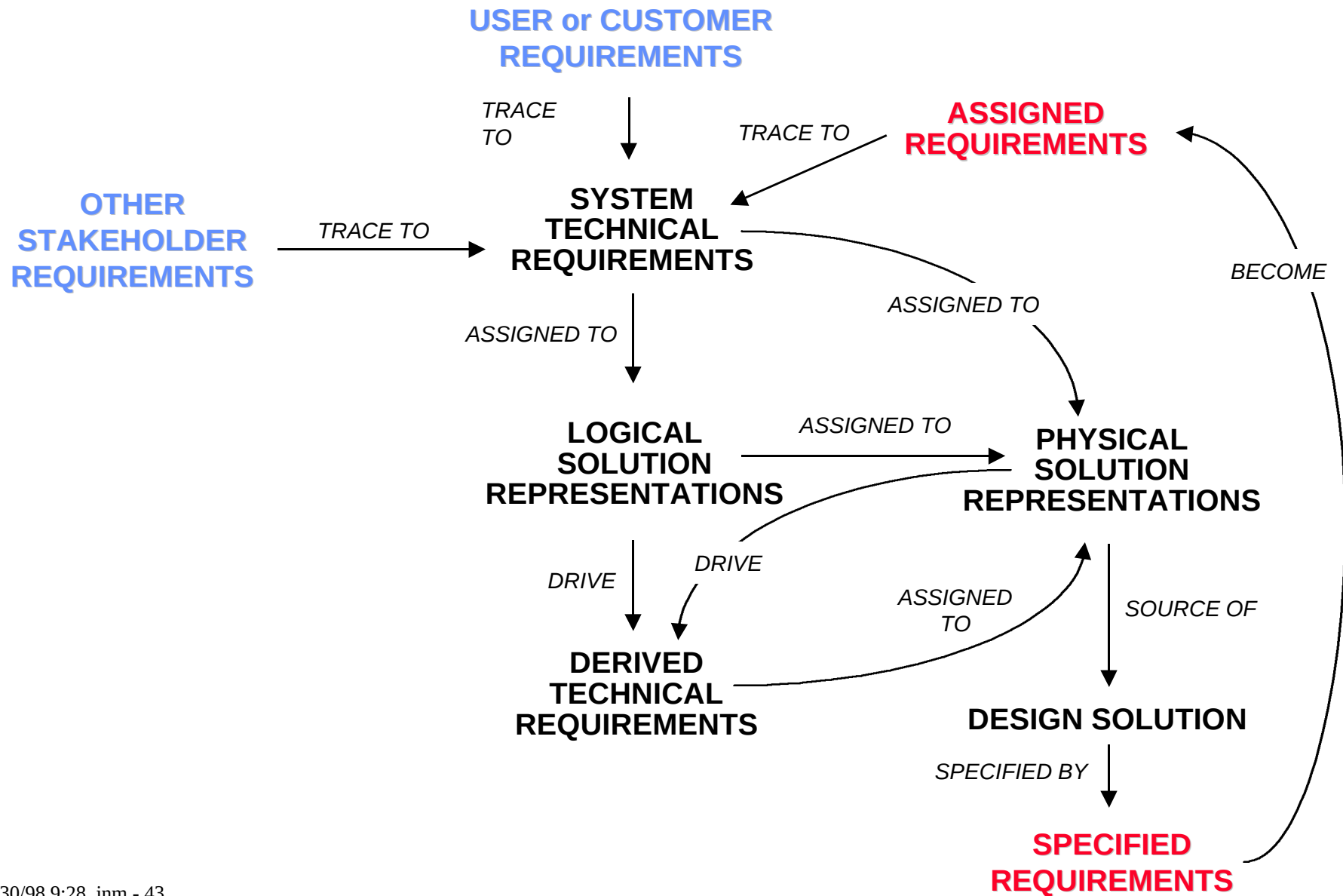
- » *Conditions* of interaction between items

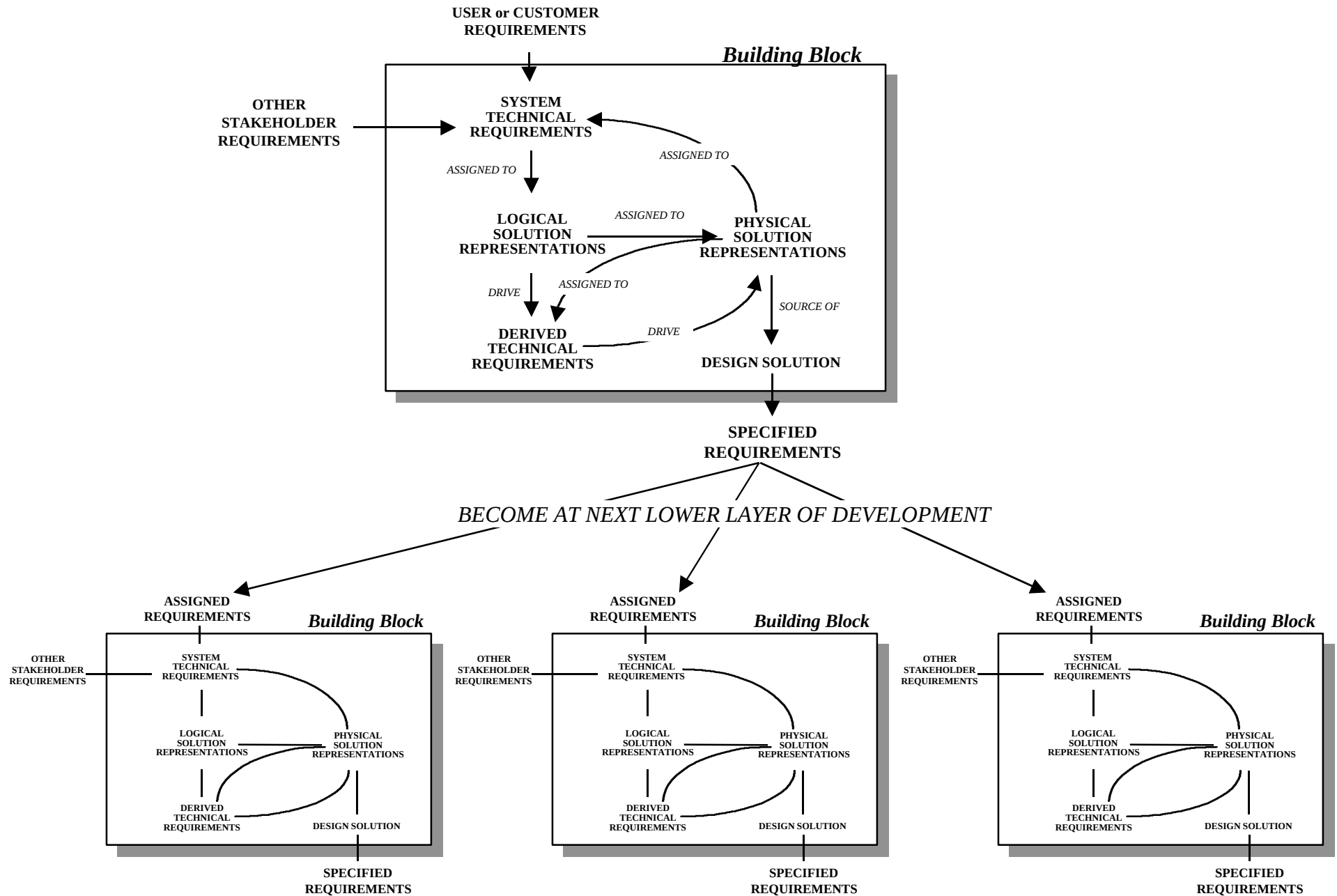
- ... could be functional, physical, logical, . . .

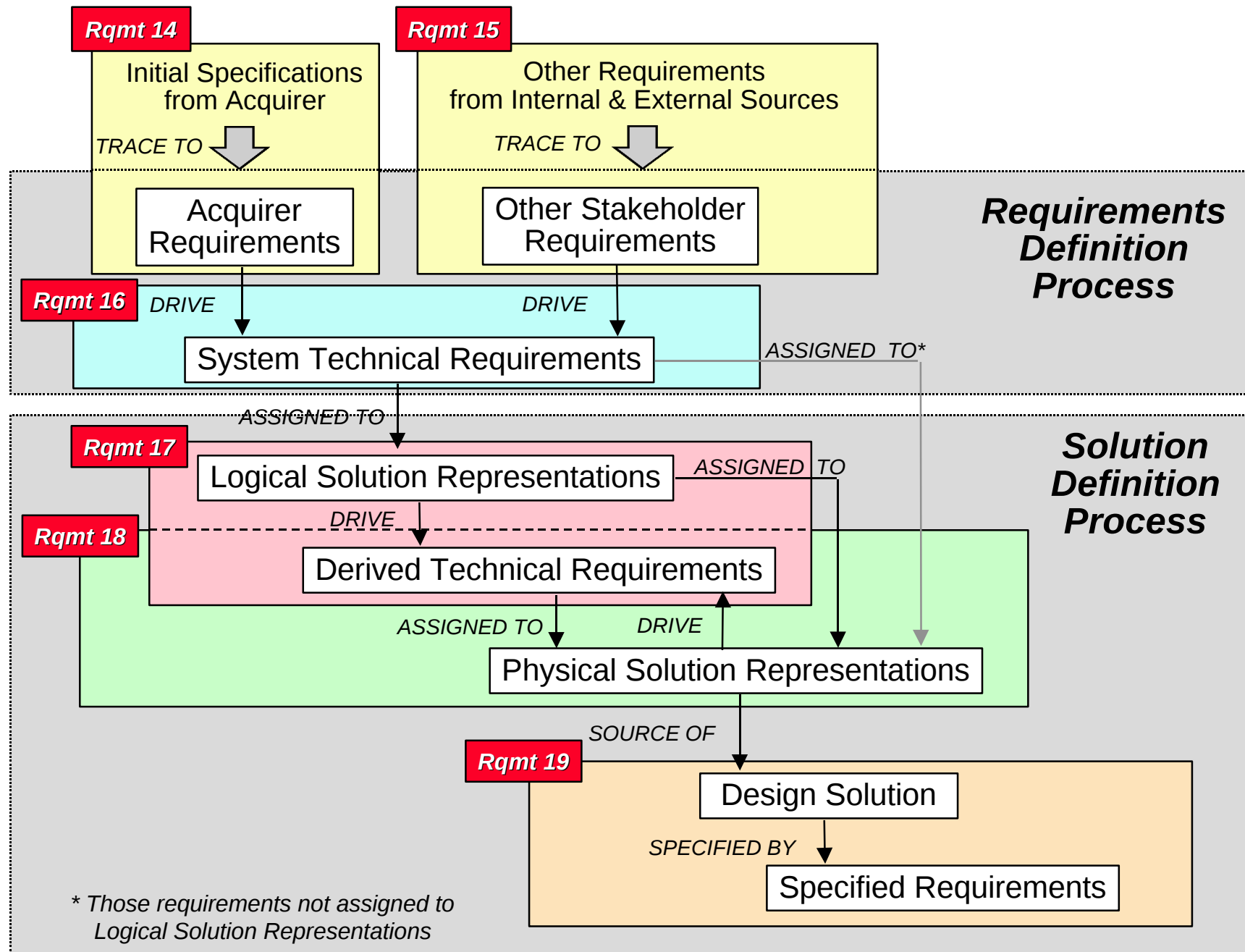
Other Information Related to Requirements

- Not to be confused with “**Requirement Statements**” ...
 - » Which are sentences or phrases that contain *one or more of the basic types* above (functional, performance, interface)
 - “The ABC subsystem shall identify internal failures within 2 seconds of their occurrence after the ‘BIT Test Start’ command is received.”
 - ... which *contains all 3 basic types* of requirements
- Also need to know **Conditions** for each type ...
 - » *Conditions* under which the *requirement is valid*
 - Environmental
 - States and modes
 - Physical configurations
 - Geographic locations
 - ...
- **Constraints** are those special requirements where *trade-offs cannot be made*

Requirement Relationships







Verification & Validation

• Verification

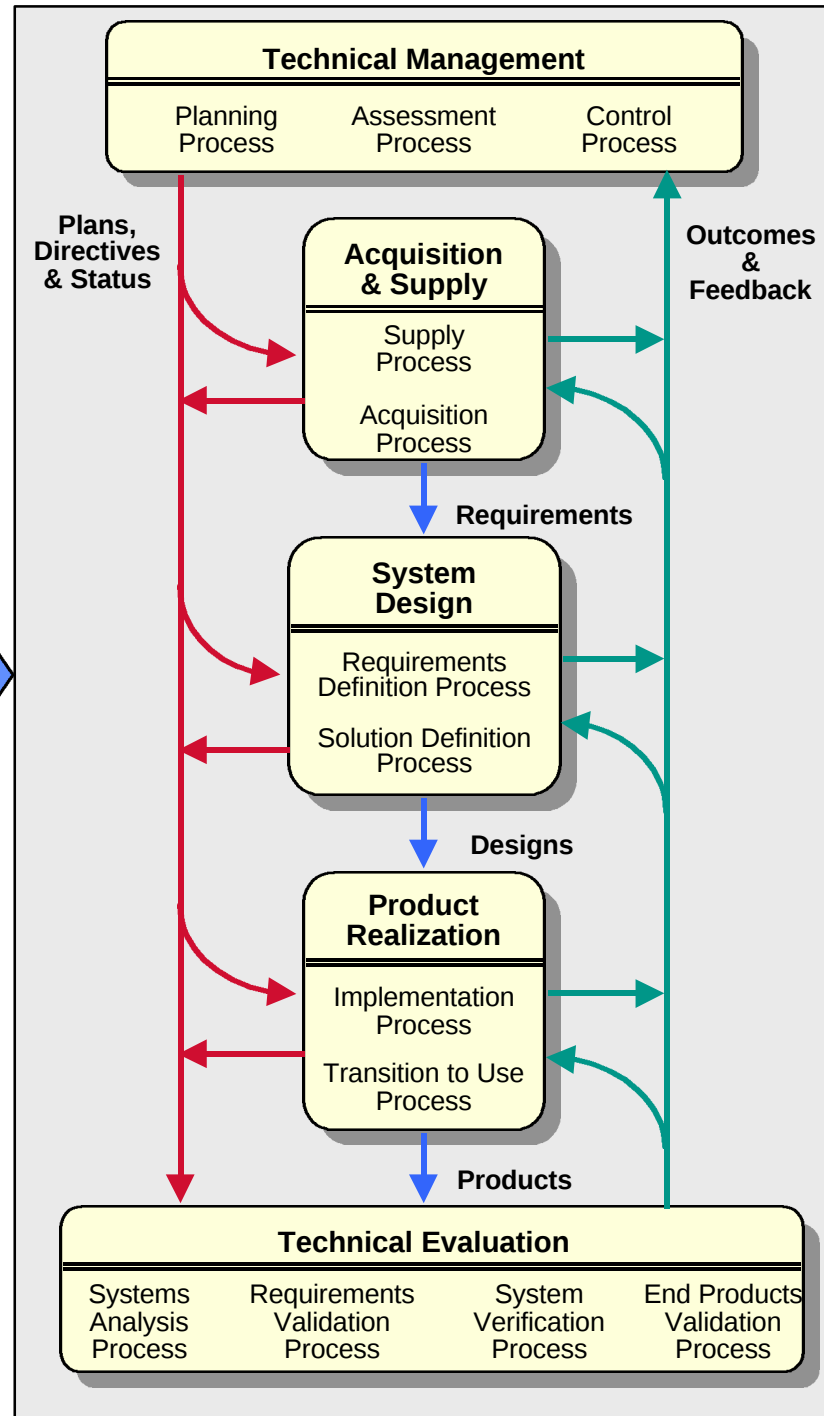
- » Check **compliance** against **specified requirements**
- » “Have you done the *job right*?”
- » Two Types
 - **Product & Process Qualification**
 - Full compliance to specification
 - **Product requalification** may be necessary when Product is “redesigned”
 - **Process requalification** may be necessary when Process is “restarted”
 - **Product Acceptance**
 - Full compliance to key criteria
 - Done on every unit or on sample basis
 - Can be done prior to shipment or after installation

• Validation

- » Check **satisfaction** of **stakeholders**
- » “Have you done the *right job*?”
- » Two Types
 - **Requirements Validation**
 - Check for “traceability”
 - “Have we missed any requirements?”
 - “Do we have extraneous requirements?”
 - **Product Validation**
 - Check if meeting “needs and expectations” of stakeholders

Top-Level Process Diagram

Acquisition Request



System Products



Summary & Recommendations

- **EIA 632 will be the US National Standard on Engineering of Systems**
 - » Should be used to develop Corporate Policies & Procedures
 - » Corporate Standard Practices should be Fully Compliant with EIA 632
- **This standard should be made available to all Systems Engineers**
 - » They will be expected to “Lead the Way”
 - » Industry Methods & Tools will use EIA 632 as a baseline for development and upgrades

For More Information

- **EIA Engineering Operations Council**
 - » <http://www.eia.org/gd/gdeoc/>
- **EIA G47 Systems Engineering Committee**
 - » Hal Wilson, Chair
 - » Wilson_Hal@prc.com
- **EIA 632 Working Group**
 - » James Martin, Chair
 - » j-martin@ti.com
 - » (972)575-0182
- **International Council on Systems Engineering (INCOSE)**
 - » <http://www.incose.org/>
 - » incose@halcyon.com

Get Your Own Copy

- **Global Engineering Documents**

- » <http://global.ihs.com/>
- » SP-3537 (Standards Proposal)
Available Now
- » Production Release in November 1998

Conclusions

- **EIA 632 has significant enhancements over the Interim Version**
 - » Acquirer/Supplier Processes
 - » Commercial Environment
 - » Stakeholder Requirements
 - » Entire Engineering Effort
- **Useful as a Framework for Corporate Practices and 2nd-Tier Standards**
 - » Company Policies & Procedures
 - » Industry-Specific Standards