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A SYSTEM ENGINEERING APPROACH TO SMART PRODUCT EXPLORATION

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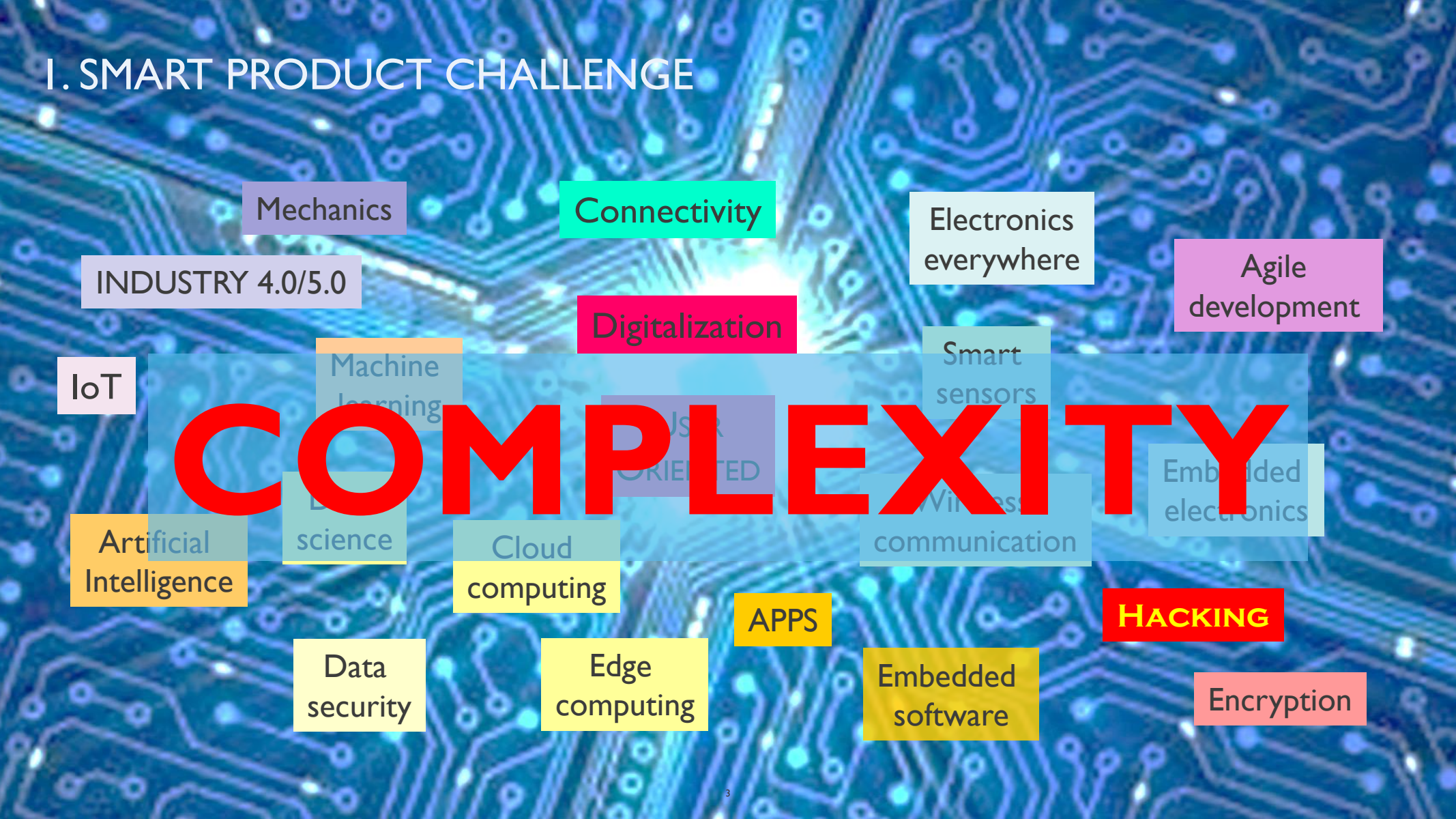
Met steun van:

AGENTSCHAP
INNOVEREN &
ONDERNEMEN

CONTENT

1. Smart product challenge
2. Life Cycle Stages and Life Cycle Processes per ISO/IEC/IEEE 15288
3. New Product Exploration: mastering the Fuzzy Front End
4. Business/Mission Analysis
5. Product Research Stage Gating

1. SMART PRODUCT CHALLENGE



1. SMART PRODUCT CHALLENGE

THREE KEY QUESTIONS

- What do our customers and stakeholders need/want?

  The NEED
- What can we offer to answer that need?

  The SOLUTION
- How can we make some money?

  The BUSINESS

VALIDATION:

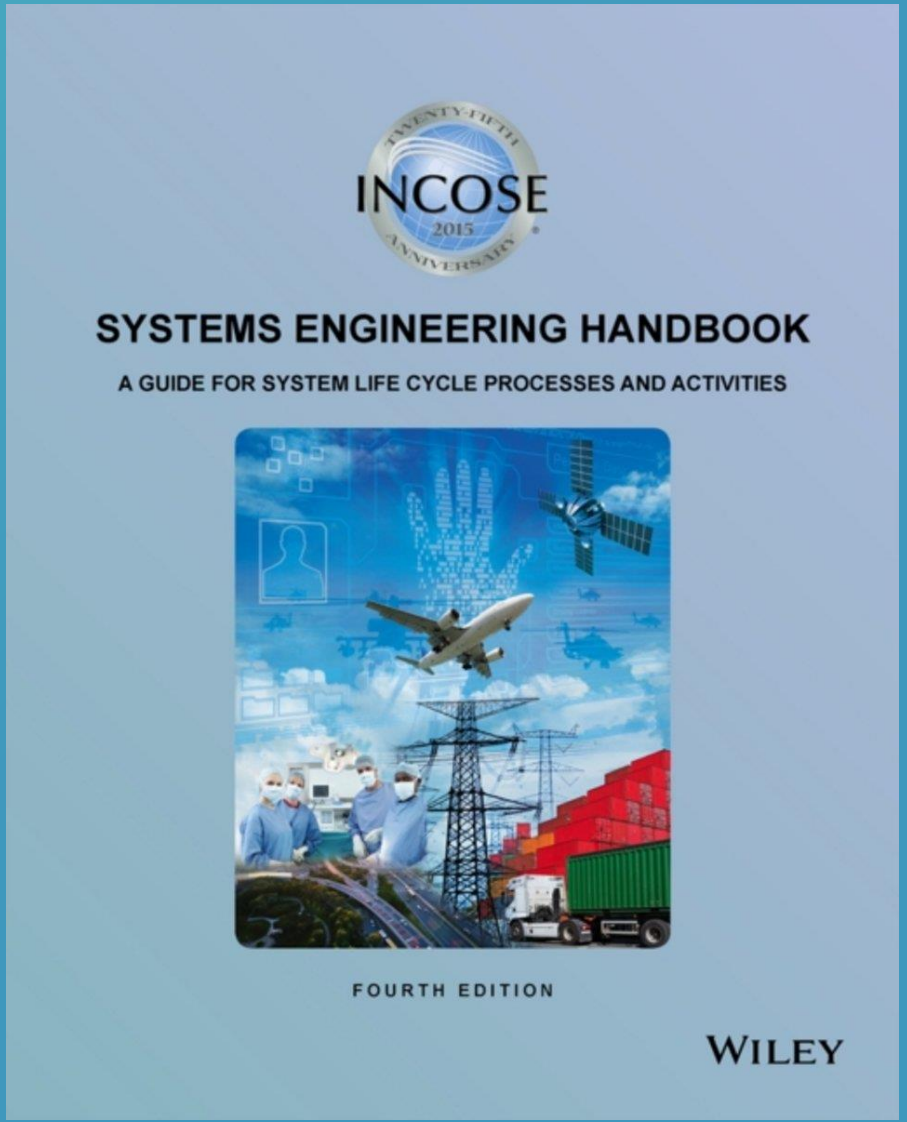
Is the solution DESIRABLE, FEASIBLE & VIABLE?

1. SMART PRODUCT CHALLENGE

What competences and capabilities do we need?

- In-house
- From partners and suppliers

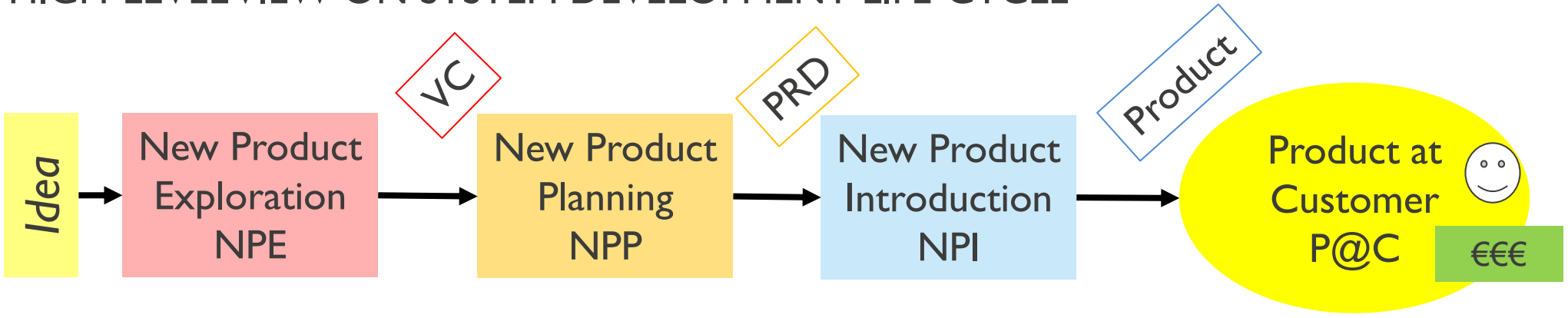
A SYSTEM ENGINEERING APPROACH
ISO/IEC/IEEE 24748-1 & 15288



INCOSE: INternational COunsel on System Engineering

2. SYSTEM LIFE CYCLE STAGES

HIGH-LEVEL VIEW ON SYSTEM DEVELOPMENT LIFE-CYCLE



NPE - Problem/solution research: user, market, business, technical/industrial feasibility

→ *Validated Concept (VC)*

NPP - Plan the product development, operations and business set-up

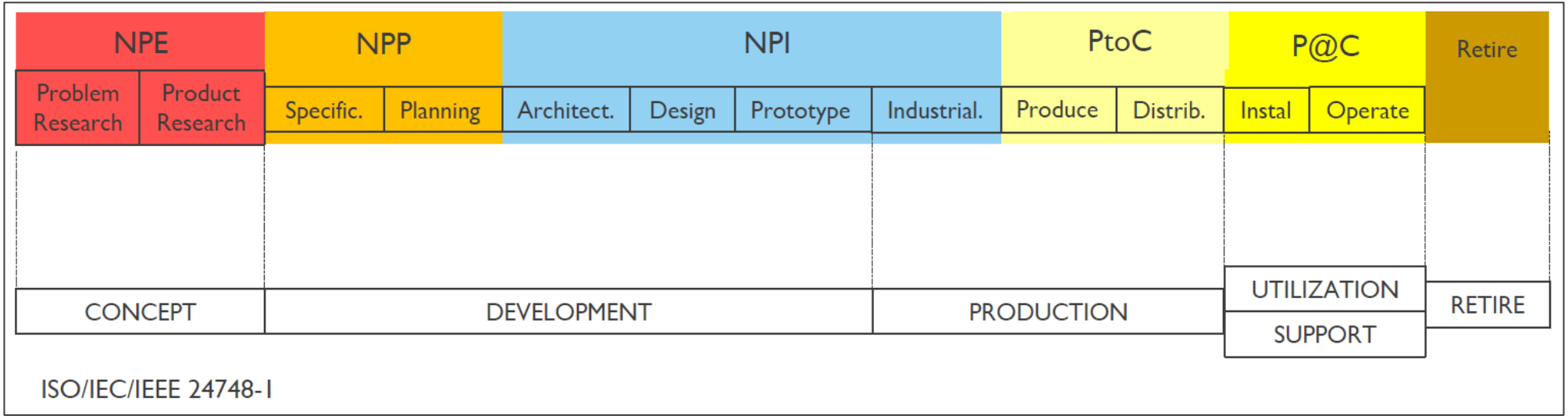
→ *Product Requirements Document (PRD), development, operation and business plans*

NPI - Execution of product development, industrialization, operations and business roll-out

→ *Qualified, documented product delivered to customer.*

2. SYSTEM LIFE CYCLE STAGES

TOTAL VIEW & ALIGNMENT WITH ISO/IEC/IEEE 24748-1

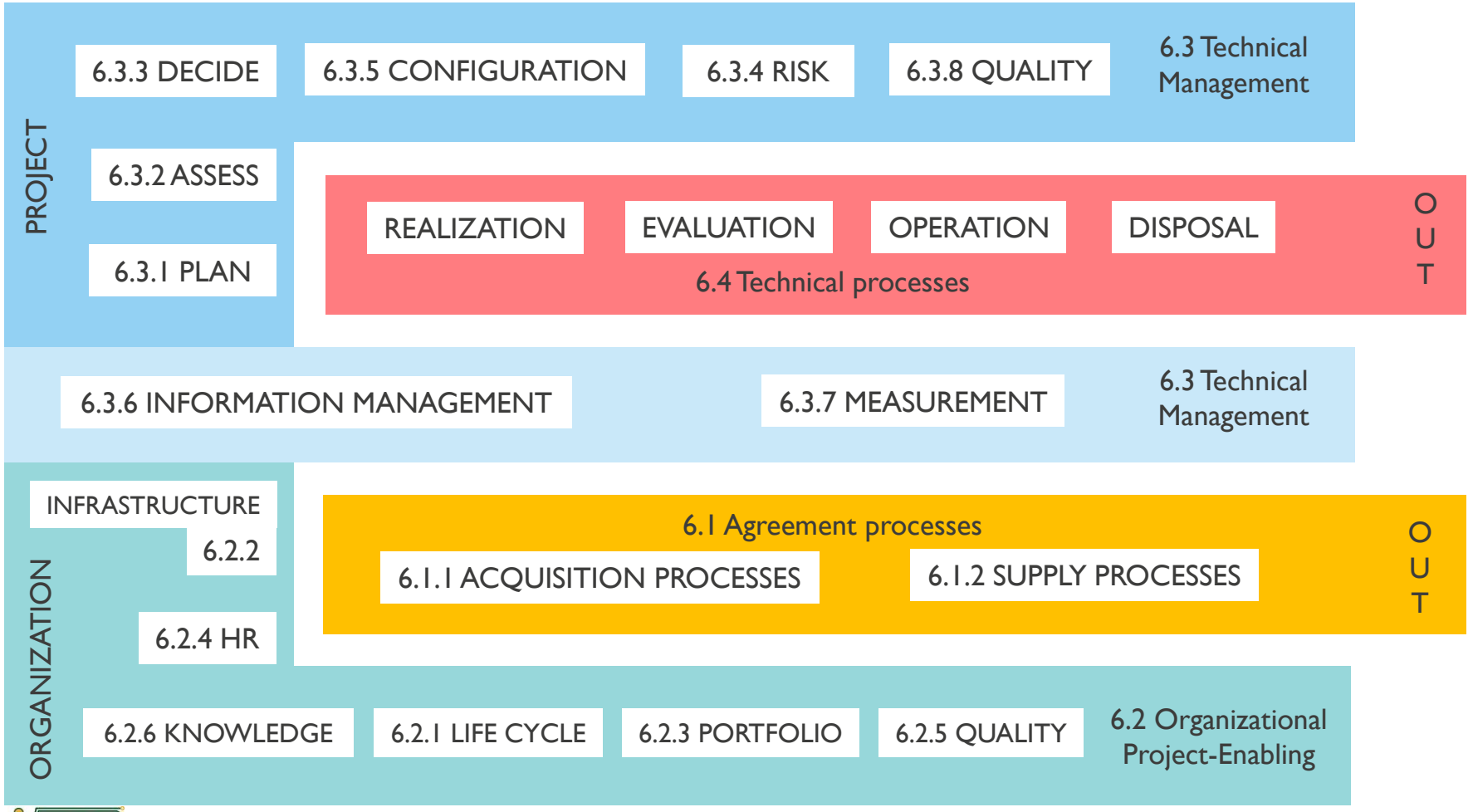


Stage- & Phase-gates

@ major decision instances

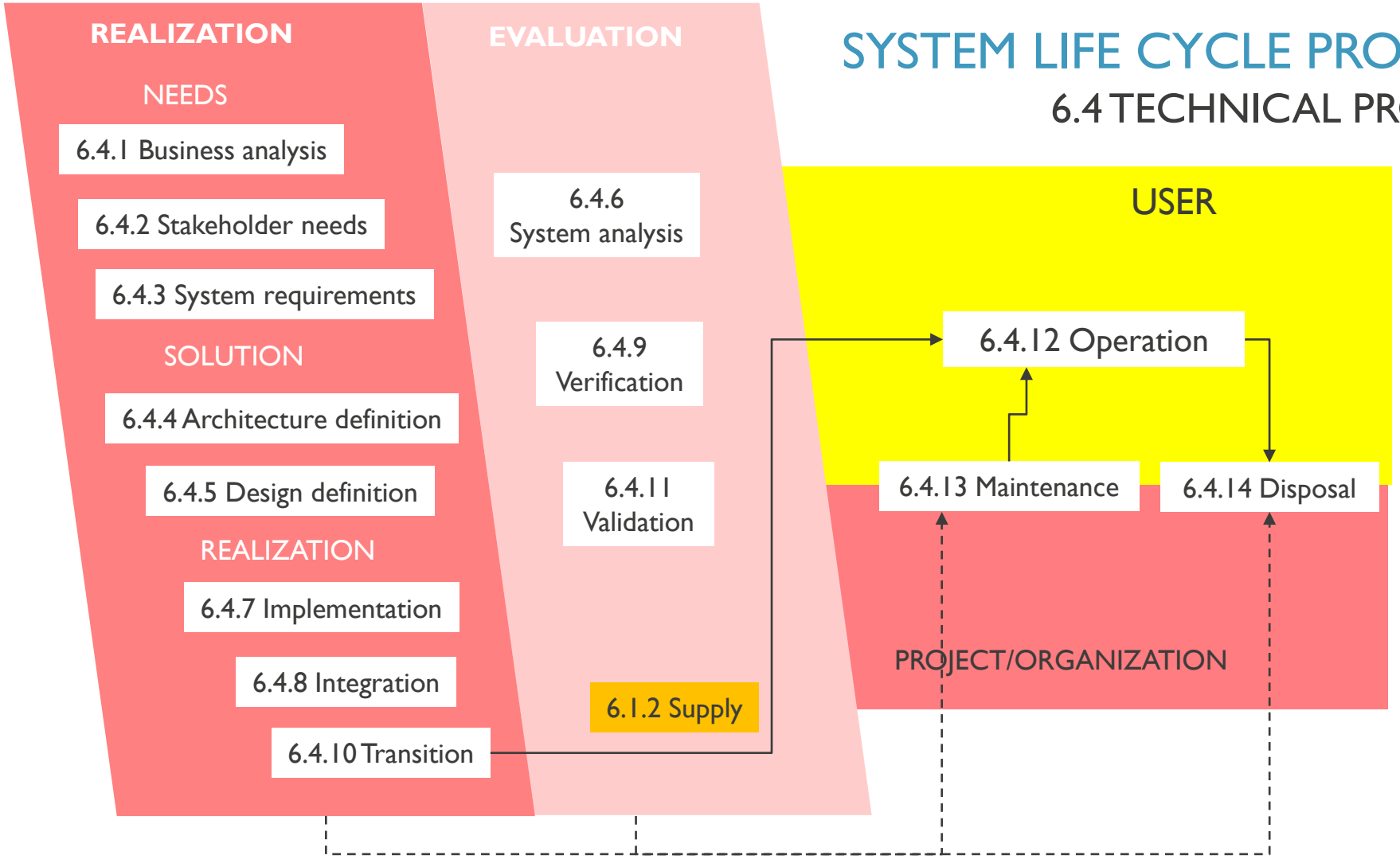
@ responsibility transfer instances

2. SYSTEM LIFE CYCLE PROCESSES PER ISO/IEC/IEEE 15288



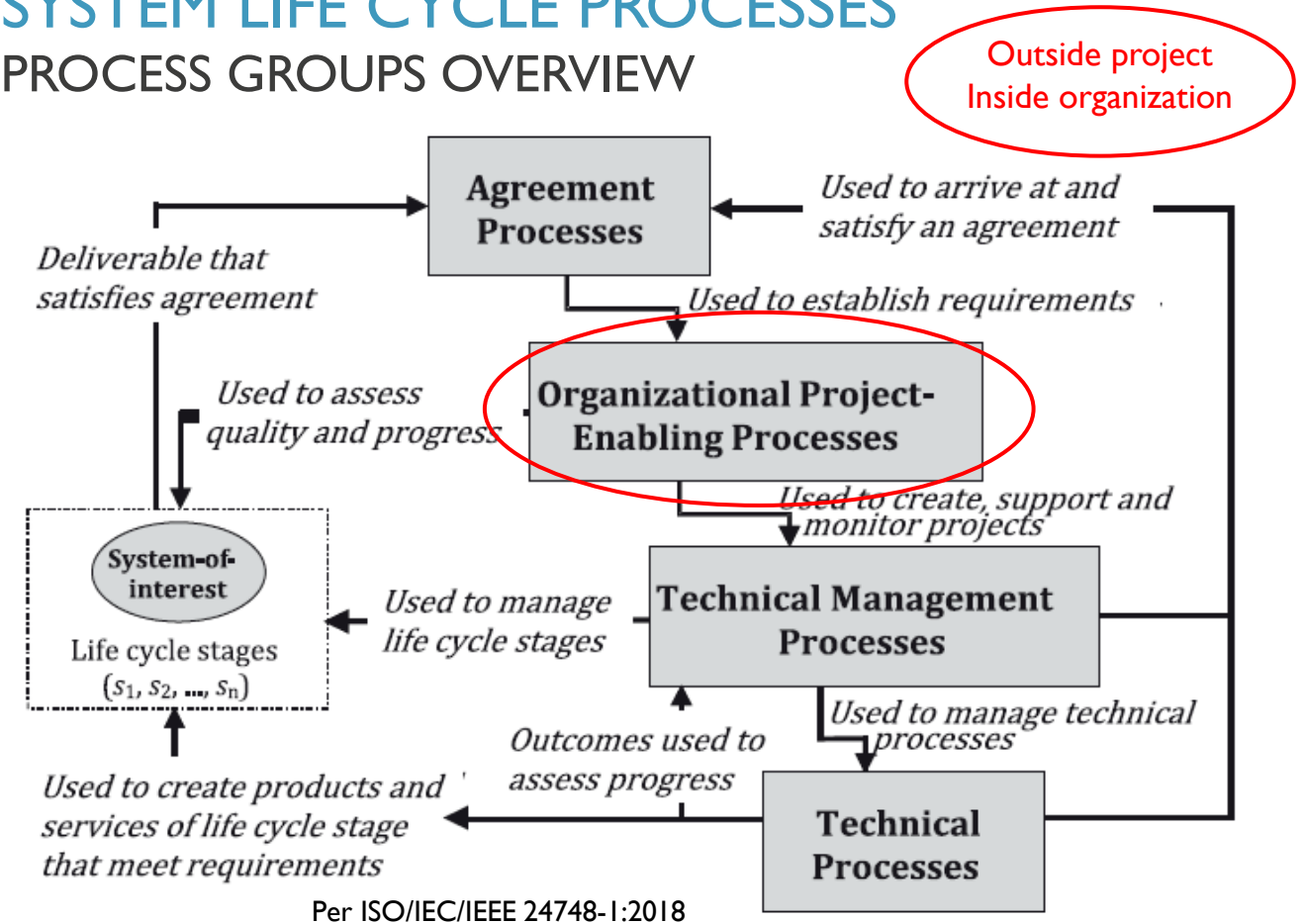
SYSTEM LIFE CYCLE PROCESSES

6.4 TECHNICAL PROCESSES



SYSTEM LIFE CYCLE PROCESSES

PROCESS GROUPS OVERVIEW



Per ISO/IEC/IEEE 24748-1:2018
Per ISO/IEC/IEEE 15288: 2015
Per ISO/IEC/IEEE 12207-1:2017

System Life Cycle Processes

Agreement Processes	Technical Management Processes	Technical Processes
Acquisition Process (Clause 6.1.1)	Project Planning Process (Clause 6.3.1)	Business or Mission Analysis Process (Clause 6.4.1)
Supply Process (Clause 6.1.2)	Project Assessment and Control Process (Clause 6.3.2)	Stakeholder Needs & Requirements Definition Process (Clause 6.4.2)
Organizational Project-Enabling Processes	Decision Management Process (Clause 6.3.3)	System Requirements Definition Process (Clause 6.4.3)
Life Cycle Model Management Process (Clause 6.2.1)	Risk Management Process (Clause 6.3.4)	Architecture Definition Process (Clause 6.4.4)
Infrastructure Management Process (Clause 6.2.2)	Configuration Management Process (Clause 6.3.5)	Design Definition Process (Clause 6.4.5)
Portfolio Management Process (Clause 6.2.3)	Information Management Process (Clause 6.3.6)	System Analysis Process (Clause 6.4.6)
Human Resource Management Process (Clause 6.2.4)	Measurement Process (Clause 6.3.7)	Implementation Process (Clause 6.4.7)
Quality Management Process (Clause 6.2.5)	Quality Assurance Process (Clause 6.3.8)	Integration Process (Clause 6.4.8)
Knowledge Management Process (Clause 6.2.6)		Verification Process (Clause 6.4.9)
		Transition Process (Clause 6.4.10)
		Validation Process (Clause 6.4.11)
		Operation Process (Clause 6.4.12)
		Maintenance Process (Clause 6.4.13)
		Disposal Process (Clause 6.4.14)

2. LIFE CYCLE STAGES & PROCESSES

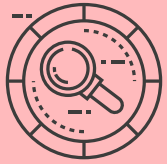
PLC STAGES VERSUS PLC PROCESSES (ISO/IEC/IEEE 15288: 2015)

Prepare	
Qualify	
Implement	
Execute	
Monitor	
Improve	
Close	

ELECTRONIC SYSTEMS		Agreement		Technical														
STAGE	Phase			Stakeholder needs	System requirements	Architecture	Design	System analysis	Implementation	Integration	Verification	Transition	Validation	Operation	Maintenance	Disposal
	Technology C															
NPE	Problem Rese															
	Product Rese															
NPP	Product Spec															
	Product Plann															
NPI	Architecture															
	Design															
	Prototype															
	Industrialisation															
PtoC	Production															
	Distribution															
P@C	Installation															
	Product Operation															
Retire	Decommisioning															
	End-of-Life															

Monitor and learn for next generation and next products

3. NEW PRODUCT EXPLORATION
WHAT TO EXPLORE?



New Product Exploration

User/stakeholder related (desirability):

- User/stakeholder's problem/need vs solution

Product related (technical feasibility)

- Technology readiness, availability, accessibility
- Feasibility of (internal) product life cycle realization and support
- Supply chain readiness and (external) enabling system readiness
- Product Life Cycle concepts: risks, scenario's, resources and costs

Business related (viability)

- Company fit
- Market/competition/ecosystem/society/environment fit
- Business/revenue model

Validated Concept

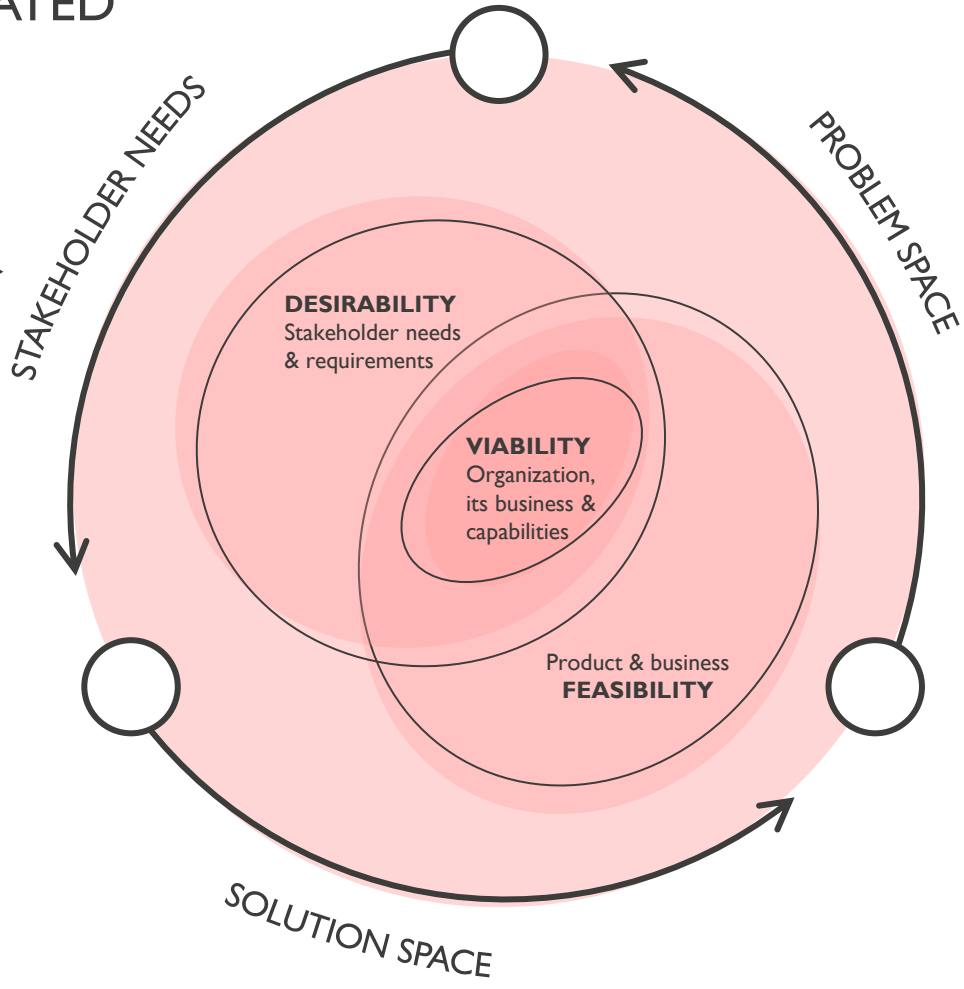
3. NEW PRODUCT EXPLORATION

THE CHALLENGE: EVERYTHING IS INTERRELATED

RESEARCH PLAN

STAGE-GATED PRODUCT RESEARCH

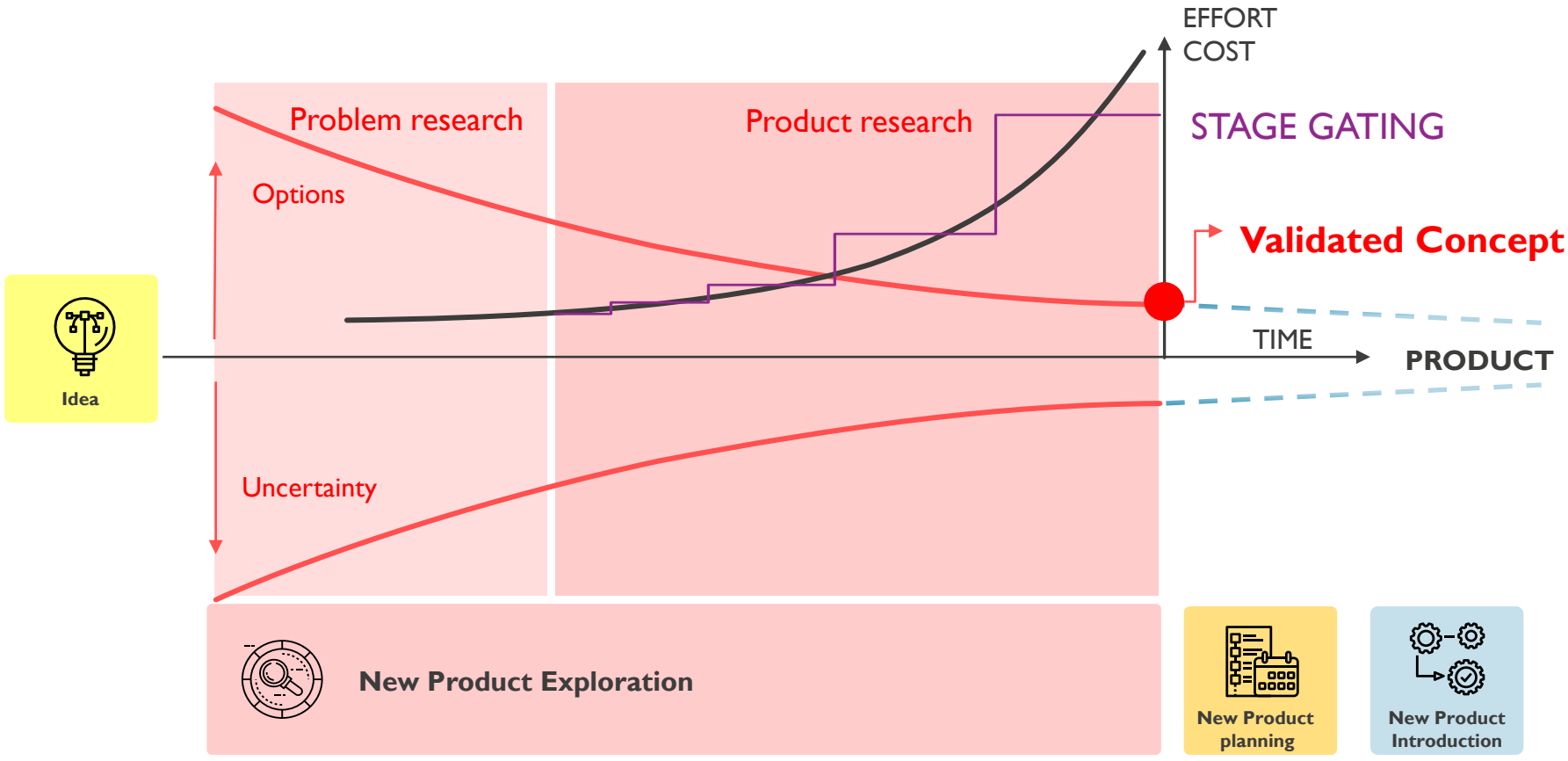
Low-Cost PROBLEM RESEARCH



How to manage this Fuzzy Front End?

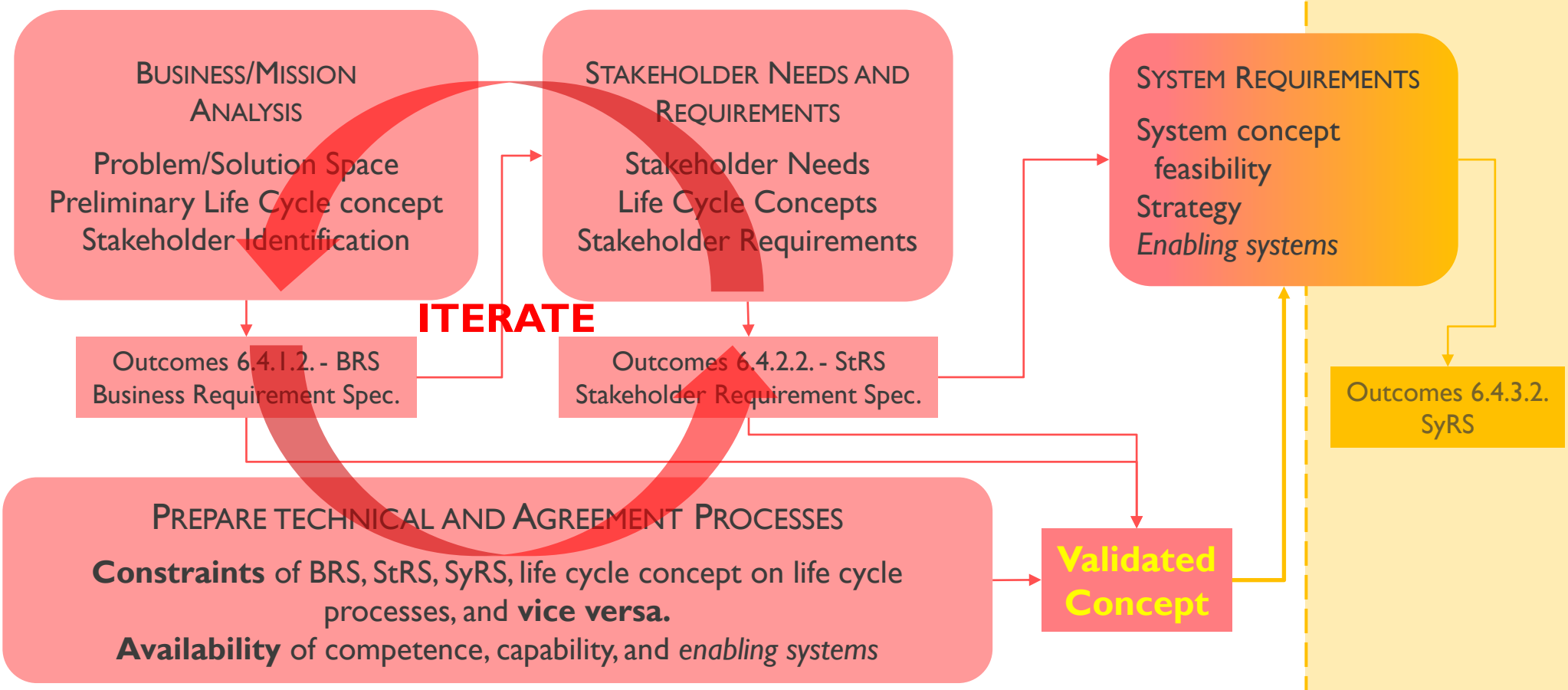
3. NEW PRODUCT EXPLORATION

FUNNELING THE OPTIONS



3. NEW PRODUCT EXPLORATION

A SYSTEM ENGINEERING VIEW (INCOSE – ISO/IEC/IEEE 15288)

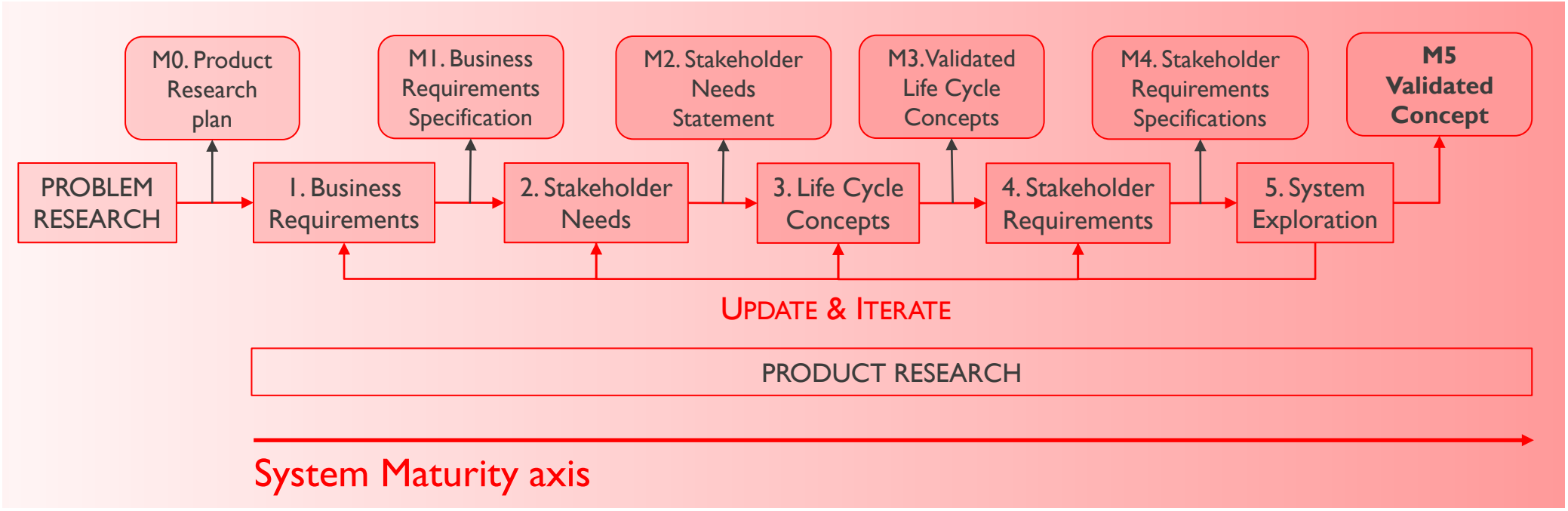


3. NEW PRODUCT EXPLORATION
PROBLEM RESEARCH (PRE-STUDY)

- First low-cost assessment of all relevant topics: desk research et al.
- Identification of problem/need - solution options
- First "filtering"
- Identification of items that require further exploration and validation.
- Exploration plan for Product Research:
  Output:
- Obtain go for investment in further exploration: PRODUCT RESEARCH.

3. NEW PRODUCT EXPLORATION

MILESTONE BASED STAGE GATING:



STAGE GATE DECISIONS:

continue phase - go to next phase - return to previous phase - hold - stop

4. BUSINESS/MISSION ANALYSIS

WHAT IS ADDRESSED?

WHAT problem do we want to solve? What opportunity do we want to address?

→ Problem/Opportunity statement

Problem contexts:

- Internal problem/opportunity: *ex. Industry 4.0 upgrade of in-house production.*
- Customized solution for external customer: *ex. ODM & EMS services, infrastructure project...*
- Product or service to a market of customers: *ex. product sales*

Organization contexts:

- Mission/vision, strategic plan, Concept of Operation (ConOps), competences/capabilities...
- Constraints: competition, ecosystem, environment, society...

4. BUSINESS/MISSION ANALYSIS
WHO: IDENTIFY STAKEHOLDERS

WHO are the target customers/users? WHO are the stakeholders?

Identify stakeholders

1. System OEM **organization**: organization that engineers and markets the system.
2. System OEM **shareholders**: owners of the system OEM.
3. System OEM **management**: management of the system OEM.
4. System OEM **employees**: employees of the system OEM.
5. System OEM **partners**: partners of the system OEM.
6. System OEM **suppliers**: product and service suppliers of the system OEM.
7. System **user**: uses/operates the system.
8. System **owner**: owns the system.
   This can be the customer or the system OEM organization itself operating in a XAAS-model.
9. System **customer**: buys the system provided by the system OEM organization.
10. System **service customer**: buys services from a service provider that uses the system to provide these services.
11. **Society** and its representatives.
12. **Environment** and its representatives.
13. Others...

4. BUSINESS/MISSION ANALYSIS
HOW: SOLUTION CHARACTERIZATION

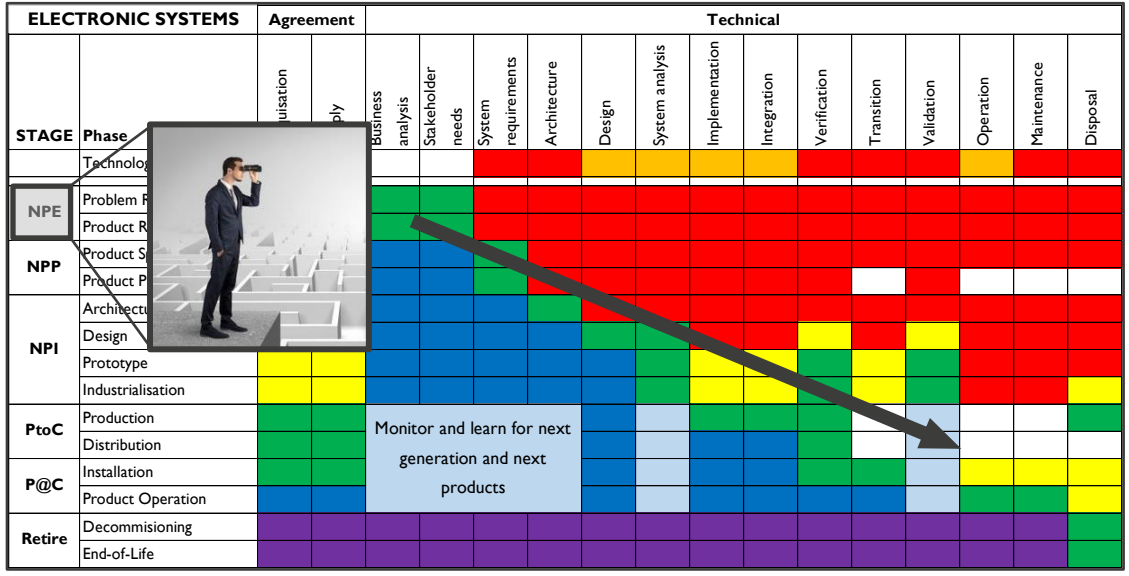
HOW will the problem be addressed?

Solution candidates

LIFE CYCLE CONCEPTS

- Operational Concept (OpsCon)
- Development
- Supply chain, production, transition to user
- Operations, support & maintenance
- End-of-Life

CANDIDATE SOLUTION CLASSES



5. PRODUCT RESEARCH STAGE GATING

THE COFFEE CASE – BUSINESS ANALYSIS

WHAT for WHO?

*"**Quality** coffee with a value adding **experience** for the active **professional** in a **work** context."*

Business/revenue models:
equipment sales (1), coffee & accessories sales (2), Coffee-As-A-Service (3), community membership...

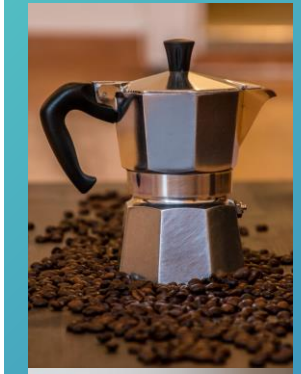
HOW: Life Cycle concepts aligned with the type of business

1. Equipment production, retail sales, after sales service...
2. Consumable sales orientation, active community, coffee promotion...
3. Service concept, 24/7 online user support, preventive maintenance...

...

5. PRODUCT RESEARCH STAGE GATING

THE COFFEE CASE: SOLUTION CLASSES



Vintage

Classic

Clooney

Smart Barista

5. PRODUCT RESEARCH STAGE GATING

PHASE 1: BUSINESS REQUIREMENTS

MILESTONE 1: BUSINESS REQUIREMENTS SPECIFICATION (BRS):

Defines business framework, constraints, business & revenue models...

BRS: Example

- *Coffee machine production is and remains core business.*
  High-end: in-house, limited capacity. Low-end: subcontracted, no capacity limits.
- *Search for large(r) margin revenue besides machine sales. Target: 30% by 2030.*
- *After sales department to become service department.*
- *No buy/sales of coffee & accessories. Partnership is an option.*
- ...

5. PRODUCT RESEARCH STAGE GATING

PHASE 2: STAKEHOLDER NEEDS

The view of the stakeholders on what is needed

MILESTONE 2: STAKEHOLDER NEEDS STATEMENT.

*A **need** is something that **is wanted or required**.*

*"**Quality** coffee with a value adding **experience** for the active **professional** in a **work** context."*

STAKEHOLDER NEEDS STATEMENT: example

- *What is "**quality**" for the **professional**?*
- *What "**experience**" is expected by the **professional**? What are the constraints (time)?*
- *What "**experience**" is expected by **management**? What are their goals and constraints?*
- *What are acceptable **operational** scenarios in the **work** context?*
- *Drop "Vintage" **solution class**: not compatible with work context's time constraints.*
- ...

5. PRODUCT RESEARCH STAGE GATING

PHASE 3: LIFE CYCLE CONCEPTS

MILESTONE 3: VALIDATED LIFE CYCLE CONCEPTS DEFINITION

LIFE CYCLE CONCEPTS: example

- *Explore & validate operational concepts:*
  1. *Coffee bar concept (bar tender interviews)*
  2. *Self-service concept (Wizard of Oz testing of user experience)*
- *Supply, service, support, maintenance, (cost) management, etc., concepts*
- *Solution classes*
  1. *Coffee bar: **Smart Barista***
  2. *Self-service: **Clooney***
- *Alignment with BRS: Two markets acceptable? Priorities? ...*

5. PRODUCT RESEARCH STAGE GATING

PHASE 4: STAKEHOLDER REQUIREMENTS

MILESTONE 4: STAKEHOLDER REQUIREMENTS SPECIFICATIONS (STRS)

A **requirement** is a statement that **can be verified and validated**.

STAKEHOLDER REQUIREMENTS: example

- *Quality: Fairtrade, premium brands.*
- *Constraints:*
  max. cost/coffee, self-service max. order+brew time, min. four tastes...
- *Safety: no glass or ceramic, closed coffee cups for take-away...*
- *Automatic ordering of supplies, tracking of servings and waste...*

5. PRODUCT RESEARCH STAGE GATING

PHASE 5: SYSTEM EXPLORATION

MILESTONE 5: VALIDATED CONCEPT

SYSTEM CONCEPTS: example

- Explore **feasibility of system concepts** and prove the **realizability**.
  - *Sensing systems availability and cost*
  - *User interface development competences*
  - *Software development capabilities*
- Define **preliminary System Requirements**.
- Create a **Validated Concept dossier** describing the validated life cycle (M3), system and system element concepts, consistent with BRS (M1), Stakeholder needs (M2) and StRS (M4).
- Draft a **preliminary development project plan**.

5. PRODUCT RESEARCH STAGE GATING

NPE GUIDELINE

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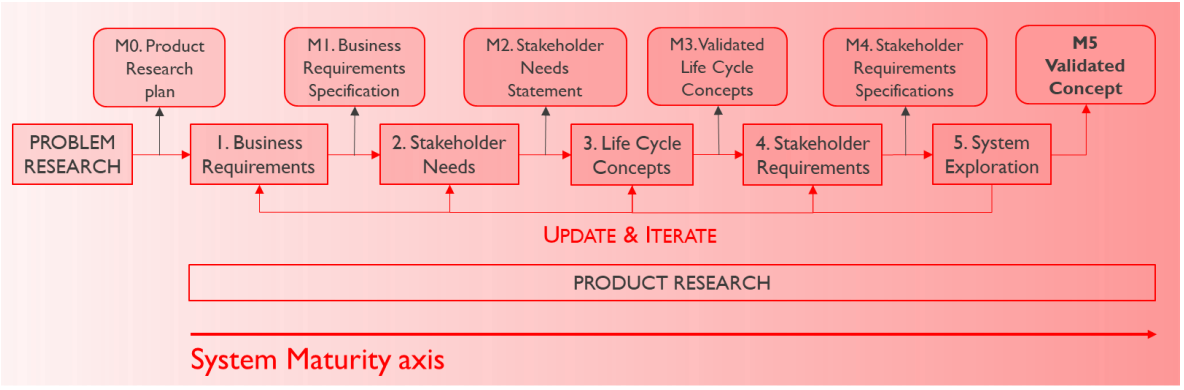
Product Life Cycle Management Guideline

EDM-P-210
New Product Exploration
A System Engineering Approach
V1.0
DRAFT 2022



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embracing a better life

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