SMART PRODUCT EXPLORATION AND CONCEPT VALIDATION

Webinar series: 20/5 – 3/6 – **17/6/22** – 3pm

Solution Concept Exploration and Validation

WALLY, WE DON'T HAVE TIME TO GATHER THE PRODUCT REQUIREMENTS AHEAD OF TIME.

I WANT YOU TO START DESIGNING THE PRODUCT ANYWAY. OTHERWISE IT WILL LOOK LIKE WE AREN'T ACCOMPLISHING ANYTHING.

OF ALL MY PROJECTS, I LIKE THE DOOMED ONES BEST.

NEWS

DILBERT © 1997 Scott Adams

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A SYSTEM ENGINEERING APPROACH TO SMART PRODUCT EXPLORATION
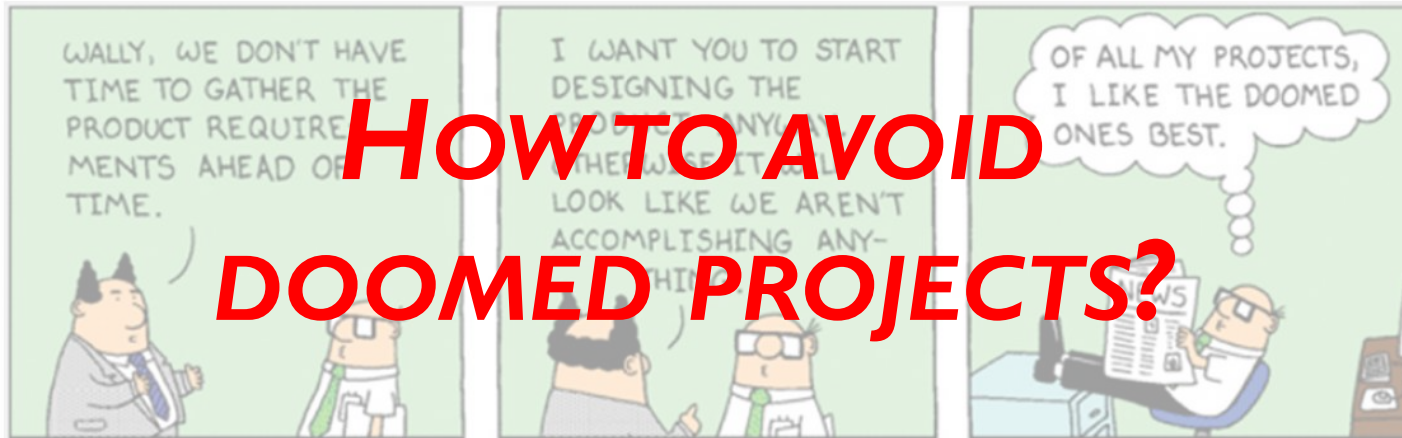## SYSTEM ANALYSIS, VERIFICATION AND VALIDATION
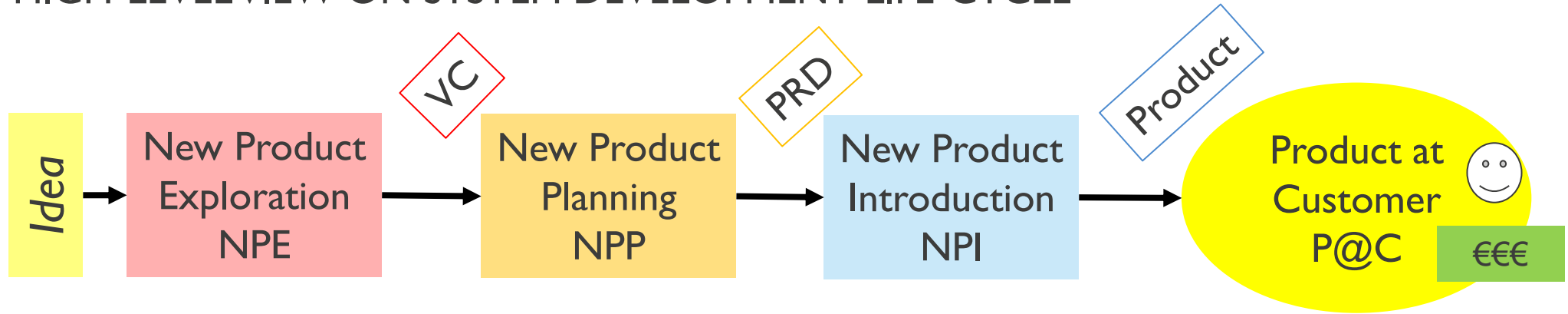
GEERT WILLEMS

Met steun van:

CONTENT

1. SMART PRODUCT CHALLENGE
HIGH-LEVEL VIEW ON SYSTEM DEVELOPMENT LIFE-CYCLE

Idea → **New Product Exploration NPE** — VC → **New Product Planning NPP** — PRD → **New Product Introduction NPI** — Product → **Product at Customer P@C** €€€

NPE   Problem/solution research: user, market, business, technical/industria 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
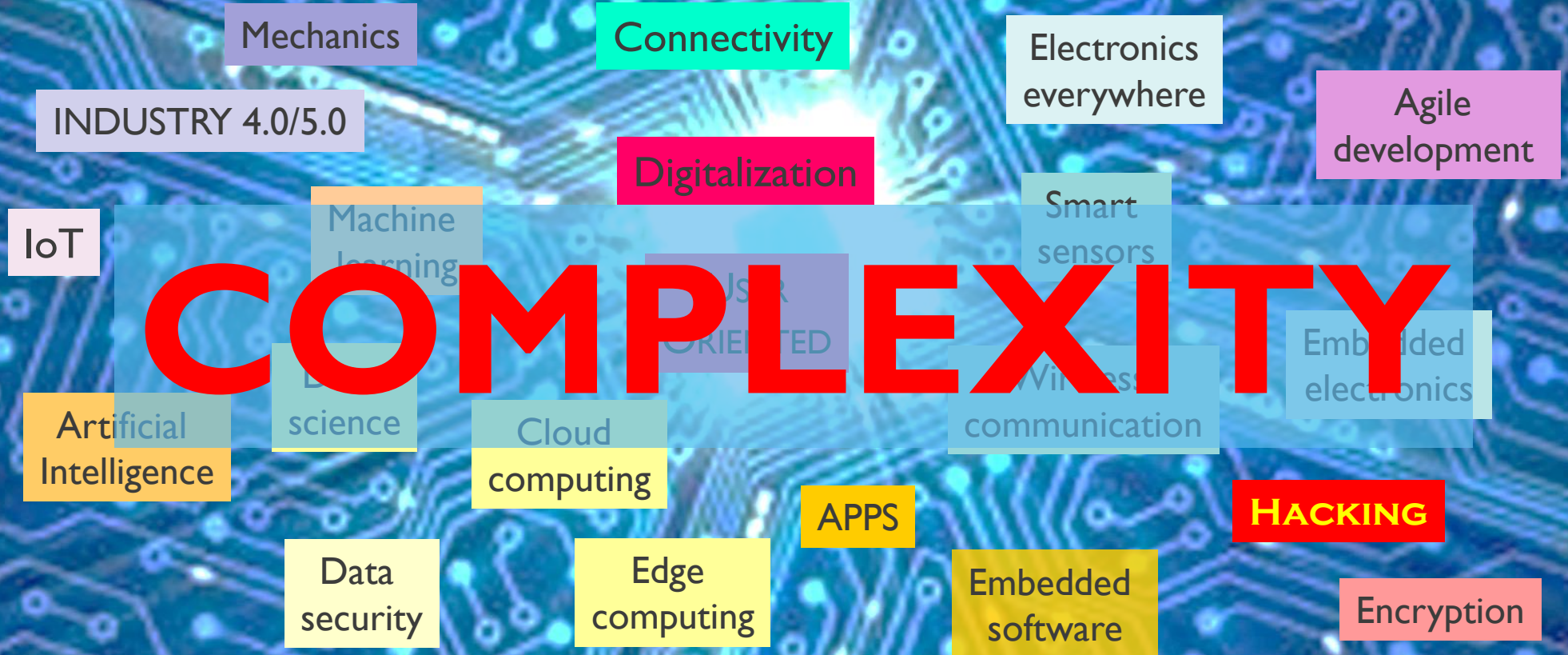   → *Qualified, documented product delivered to customer.*

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

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Mechanics

Connectivity

Electronics everywhere

INDUSTRY 4.0/5.0

Agile development

Digitalization

IoT

Machine learning

Smart sensors

USER ORIENTED

COMPLEXITY

Embedded electronics

Artificial Intelligence

Data science

Wireless communication

Cloud computing

APPS
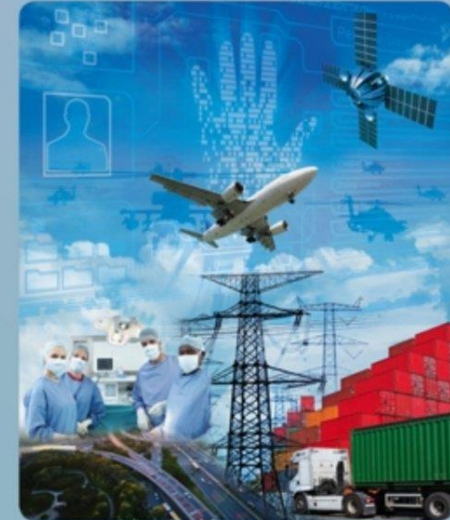
Hacking

Data security

Edge computing

Embedded software

Encryption

6

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

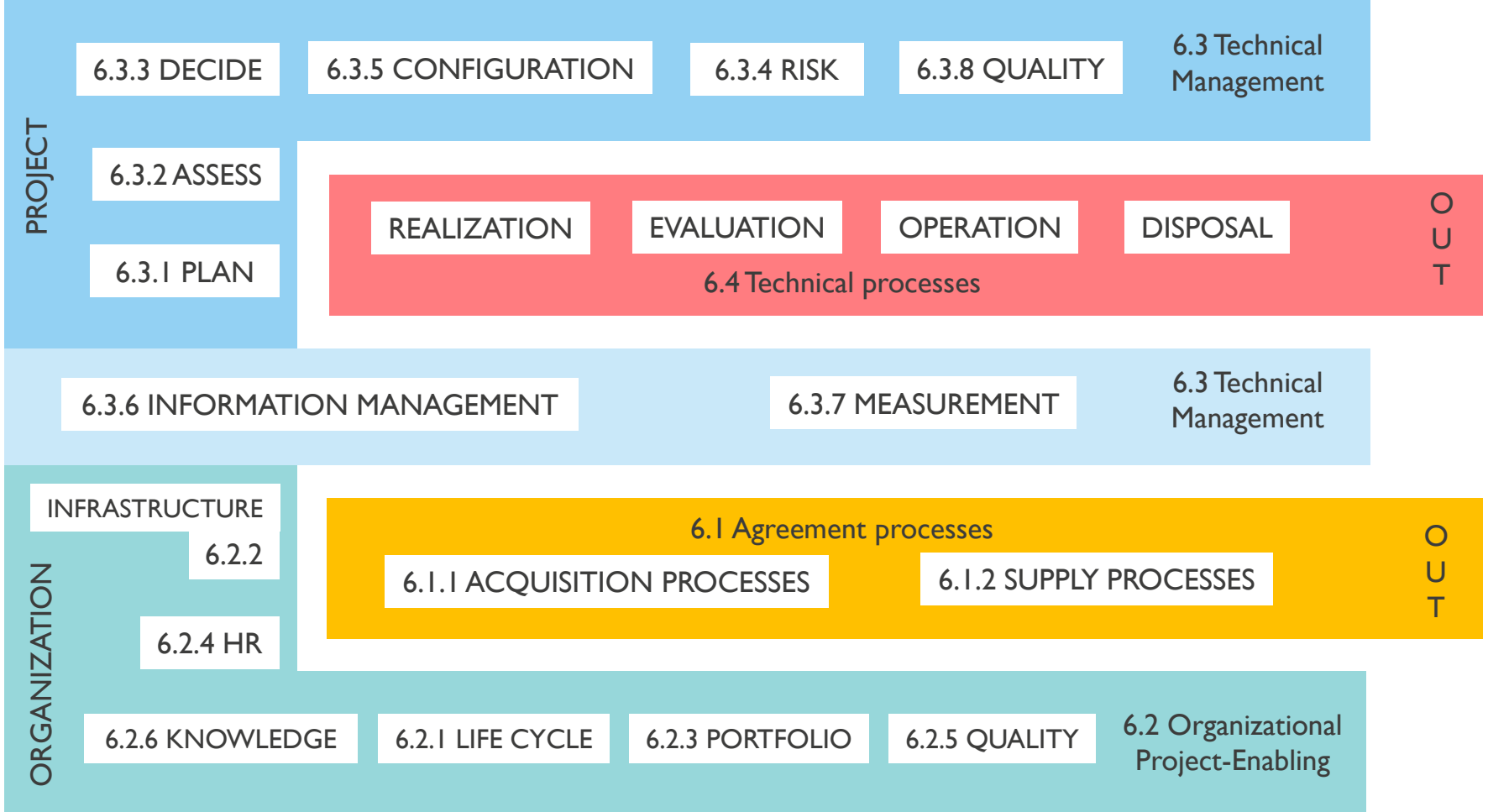INCOSE: INternational COunsel on System Engineering

SYSTEM LIFE CYCLE PROCESSES PER ISO/IEC/IEEE 15288

6.3 Technical Management

6.3.3 DECIDE	6.3.5 CONFIGURATION	6.3.4 RISK	6.3.8 QUALITY

PROJECT

6.3.2 ASSESS

6.3.1 PLAN

6.4 Technical processes

REALIZATION	EVALUATION	OPERATION	DISPOSAL

OUT

6.3 Technical Management

6.3.6 INFORMATION MANAGEMENT	6.3.7 MEASUREMENT

ORGANIZATION

INFRASTRUCTURE 6.2.2

6.2.4 HR

6.1 Agreement processes

6.1.1 ACQUISITION PROCESSES	6.1.2 SUPPLY PROCESSES

OUT

6.2 Organizational Project-Enabling

6.2.6 KNOWLEDGE	6.2.1 LIFE CYCLE	6.2.3 PORTFOLIO	6.2.5 QUALITY

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SYSTEM LIFE CYCLE PROCESSES
6.4 TECHNICAL PROCESSES

REALIZATION

NEEDS

6.4.1 Business analysis

6.4.2 Stakeholder needs

6.4.3 System requirements

SOLUTION

6.4.4 Architecture definition

6.4.5 Design definition

REALIZATION

6.4.7 Implementation

6.4.8 Integration

6.4.10 Transition

EVALUATION

6.4.6 System analysis

6.4.9 Verification

6.4.11 Validation

6.1.2 Supply

USER

6.4.12 Operation

6.4.13 Maintenance

6.4.14 Disposal

PROJECT/ORGANIZATION

SYSTEM ANALYSIS
ISO/IEC/IEEE 15288 6.4.6

2. SYSTEM ANALYSIS
PURPOSE PER ISO/IEC/IEEE 15288, 6.4.6.1.

The PURPOSE of System Analysis is:

to provide a rigorous basis of data and information for technical understanding **to aid decision-making** across the life cycle.

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2. SYSTEM ANALYSIS
ACTIVITIES PER ISO/IEC/IEEE 15288 6.4.6.3.

a) Prepare

  1) Identify analysis subject

  2) Identify stakeholders of the analysis

  3) Define scope, objectives, and level of fidelity

  4) Select analysis methods:

   - Criteria: **time, cost**, fidelity, criticality...

   - Types: expert judgement, "back of the envelop" calculation, spreadsheet computation, historical data/trends, engineering models, simulation, visualization, prototyping...

  5-7) Define analysis strategy and obtain enabling systems or services

2. SYSTEM ANALYSIS
ACTIVITIES PER ISO/IEC/IEEE 15288 6.4.6.3.

b) Perform system analysis
   1) Identify and validate assumptions
   2) Perform the required system analysis
   3) Review results for quality and validity
   4) Establish conclusions and recommendations
   5) Record the results

c) Manage system analysis: traceability and info for baselines

2. SYSTEM ANALYSIS
IN THE NEW PRODUCT EXPLORATION STAGE

BUSINESS/MISSION ANALYSIS

- Organization's mission and strategy and related gap analysis
- Problem/Opportunity and solution space analysis
- Analysis of candidate solution classes: risks, feasibility, value, cost, effectiveness

STAKEHOLDER NEEDS AND REQUIREMENTS DEFINITION

- Stakeholder needs analysis and prioritization
- Life cycle concepts analysis
- Stakeholder Requirements analysis: feasibility, costs, risks, effectiveness

2. SYSTEM ANALYSIS
IN THE NEW PRODUCT EXPLORATION STAGE

Techniques

- Desk research, interviews, surveys, etc.

- Business and life cycle analytics, models and simulation

- Living lab experiments, prototyping

- Expert judgement

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VERIFICATION PROCESS
ISO/IEC/IEEE 15288 6.4.9

3. VERIFICATION PROCESS
PURPOSE PER ISO/IEC/IEEE 15288, 6.4.9.1.

The PURPOSE of the Verification process is:

to provide objective evidence that a system or system element **fulfills** its specified **requirements** and characteristics.

The system is build right.

Therefore, requirements need to be:
quantitative, measurable, unambiguous, understandable, testable...
ISO/IEC/IEEE 29148 *Requirements Engineering*

3. VERIFICATION PROCESS
ACTIVITIES PER ISO/IEC/IEEE 15288 6.4.9.3.

a) **Prepare**
   1) Identify verification scope and actions
   2) Identify constraints that limit verification actions
   3) Select verification methods/techniques and criteria
   4-7) Define verification strategy, constraints on SyRS, architecture, design, and obtain enabling systems or services

b) **Define and perform verification procedures**

c) Manage verification analysis:
   1) Record results and anomalies
   2) Record operational incidents and problems and track their resolution
   3) Obtain agreement of stakeholder about meeting **requirements**
   4-5) Traceability and info for baselines

3. VERIFICATION
TECHNIQUES

- Inspection
- Analysis:
  calculation, logic, modeling, simulation, analogy or similarity
- Demonstration
- Test
- Sampling

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3. VERIFICATION PROCESS
IN THE NEW PRODUCT EXPLORATION STAGE

Verification of syntactic/grammatical rules of requirements:
necessary, implementationfree, unambiguous, consistent, complete, singular, feasible, traceable, verifiable.

BUSINESS/MISSION ANALYSIS

• Business model and solution classes fullfil Business Requirements (BRS)

STAKEHOLDER NEEDS AND REQUIREMENTS DEFINITION

• Life Cycle Concepts fulfill Business Requirements (BRS) and Stakeholder Requirements (StRS)

VALIDATION PROCESS
ISO/IEC/IEEE 15288 6.4.11

4. VALIDATION PROCESS
PURPOSE PER ISO/IEC/IEEE 15288, 6.4.11.1.

The PURPOSE of the Validation process is:

to provide objective evidence that the system, when in use, fulfills its business or mission objectives and stakeholder requirements, achieving its intended use in its intended operational environment.

The right system is build.

4. VALIDATION PROCESS
ACTIVITIES PER ISO/IEC/IEEE 15288 6.4.9.3.

a) Prepare
   1) Identify validation scope and actions
   2) Identify constraints that limit validation actions.
   3) Select validation methods/techniques and criteria
   4-7) Define validation strategy, constraints on SyRS, architecture, design. Obtain enabling systems or services

b) Define and perform validation procedures

c) Manage validation analysis:
   1) Record results and anomalies
   2) Record operational incidents and problems and track their resolution
   3) Obtain agreement of stakeholder about meeting **needs**
   4-5) traceability and info for baselines

4. VALIDATION PROCESS
IN THE NEW PRODUCT EXPLORATION STAGE

BUSINESS/MISSION ANALYSIS & STAKEHOLDER NEEDS AND REQUIREMENTS DEFINITION

- Validation of Business (BRS) and Stakeholder Requirements (StRS)

- Validation of Life Cycle Concepts and solution classes:
  Do they answer Business and Stakeholder **needs?**
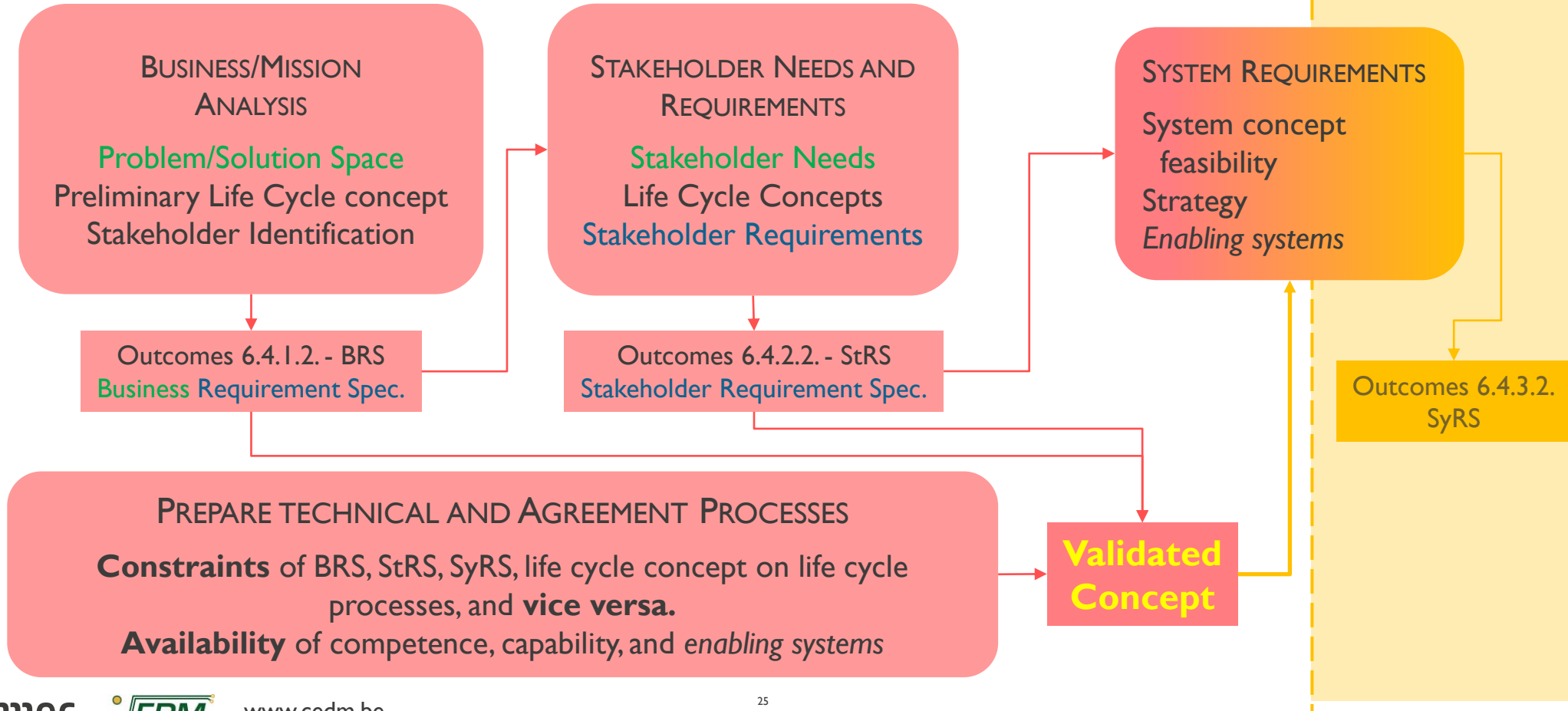
- Validated Concept

Techniques
The same as for verification but with intend to prove satisfaction of needs
i.s.o. detecting errors/defects w.r.t. requirements.

NEW PRODUCT EXPLORATION
EXECUTION IN THE NPE/CONCEPT STAGE

Validation reference
Verification reference

New Product Planning

BUSINESS/MISSION ANALYSIS

Problem/Solution Space
Preliminary Life Cycle concept
Stakeholder Identification

STAKEHOLDER NEEDS AND REQUIREMENTS

Stakeholder Needs
Life Cycle Concepts
Stakeholder Requirements

SYSTEM REQUIREMENTS

System concept feasibility
Strategy
Enabling systems

Outcomes 6.4.1.2. - BRS
Business Requirement Spec.

Outcomes 6.4.2.2. - StRS
Stakeholder Requirement Spec.

Outcomes 6.4.3.2. SyRS

PREPARE TECHNICAL AND AGREEMENT PROCESSES

Constraints of BRS, StRS, SyRS, life cycle concept on life cycle processes, and **vice versa.**
Availability of competence, capability, and *enabling systems*

Validated Concept

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Geert.Willems@imec.be
++32-498-919464
www.cedm.be