EURO2025 LEEDS

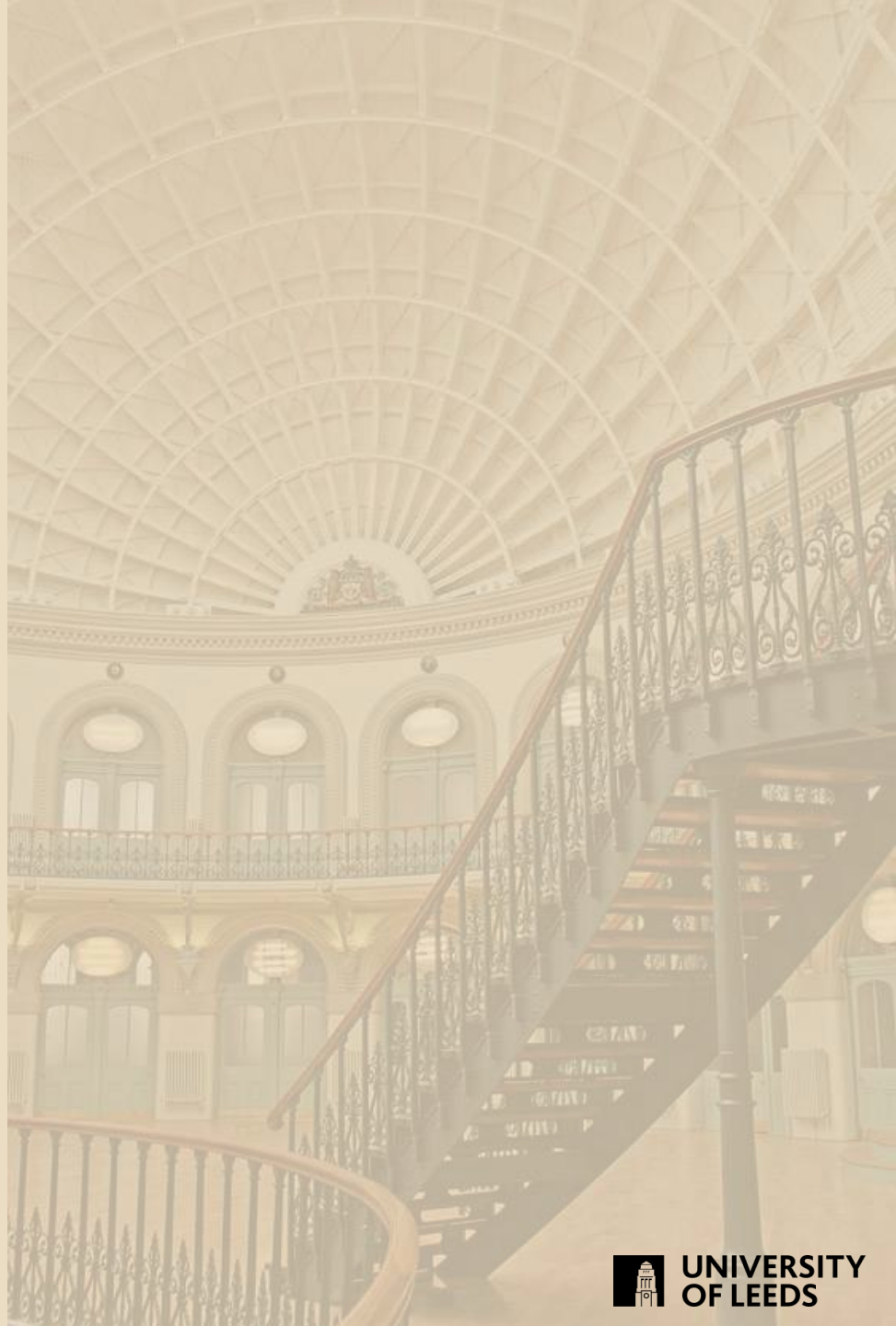
# The System(s) Needed to Create a System

Richard Beasley, CEng, MINCOSE, ESEP

RB Systems

richard@rbsystems.net

RB SYSTEMS



EURO THE ASSOCIATION OF EUROPEAN OPERATIONAL RESEARCH SOCIETIES

hexaly

OPERATIONAL RESEARCH SOCIETY

GUROBI OPTIMIZATION

UNIVERSITY OF LEEDS

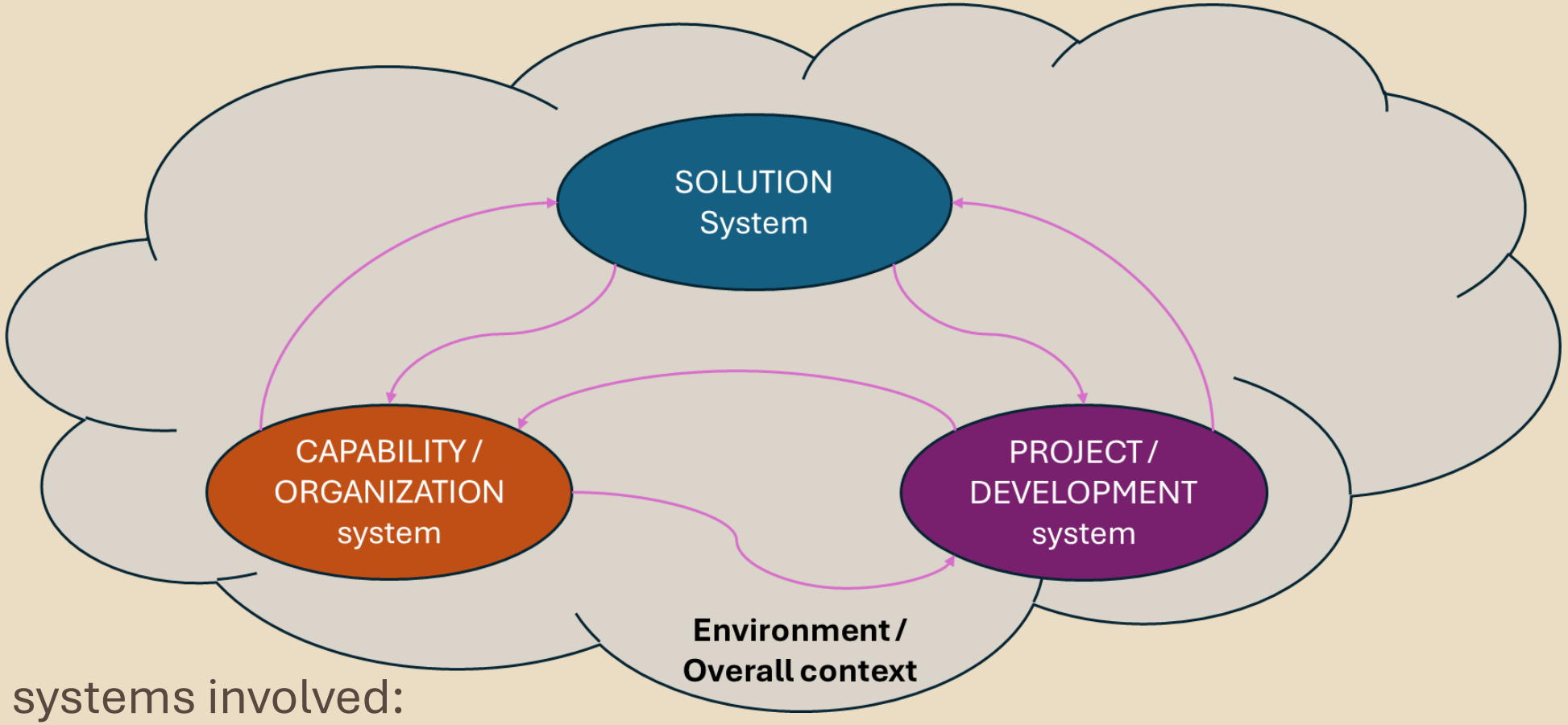
# Contents


1. Introduction
2. Three systems
3. The solution system – the technical view
4. The program / project system – the system that develops the system
5. The capability system – the system (organization) that enables the development
6. Some cases for consideration
7. Conclusions / Questions / Discussion




©RB Systems

# 2) Three Systems Involved in Creating a System




Three systems involved:

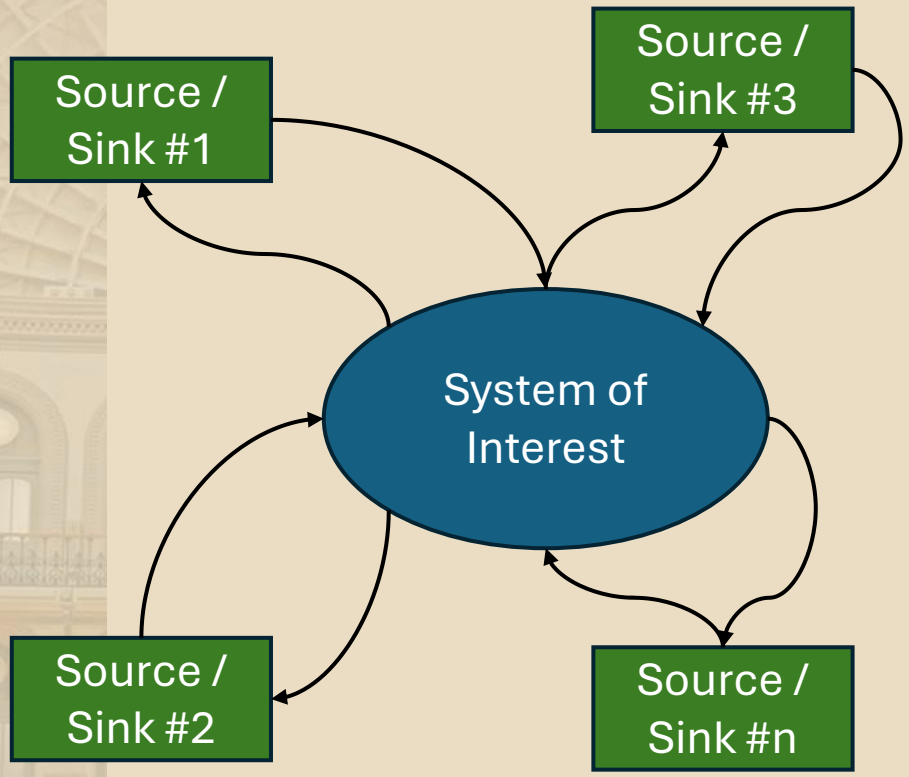
- All interacting and placing requirements on each other
- All existing in same overall context / environment



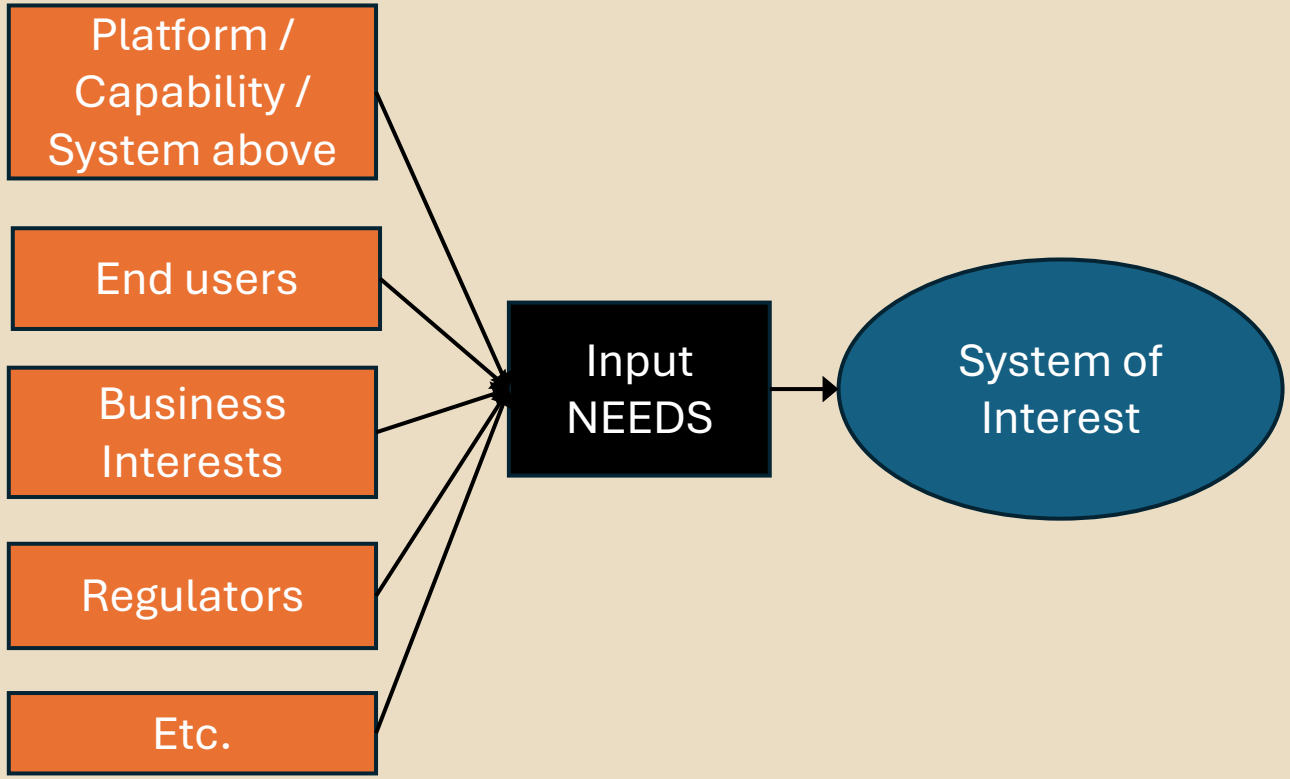
©RB Systems

# 3a) Solution System

## System has CONTEXT



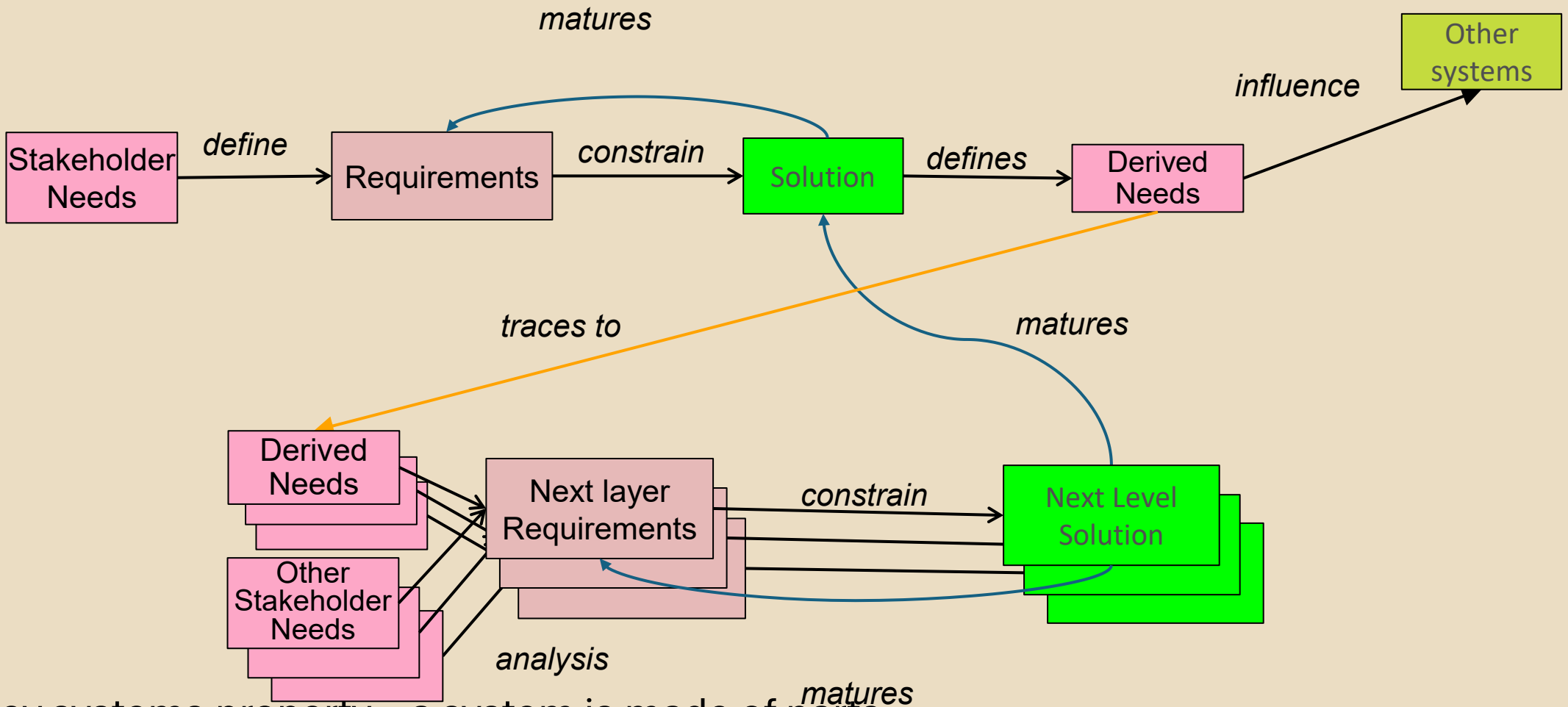

## System has STAKEHOLDERS






©RB Systems

# 3b) Solution System Layers and Iteration

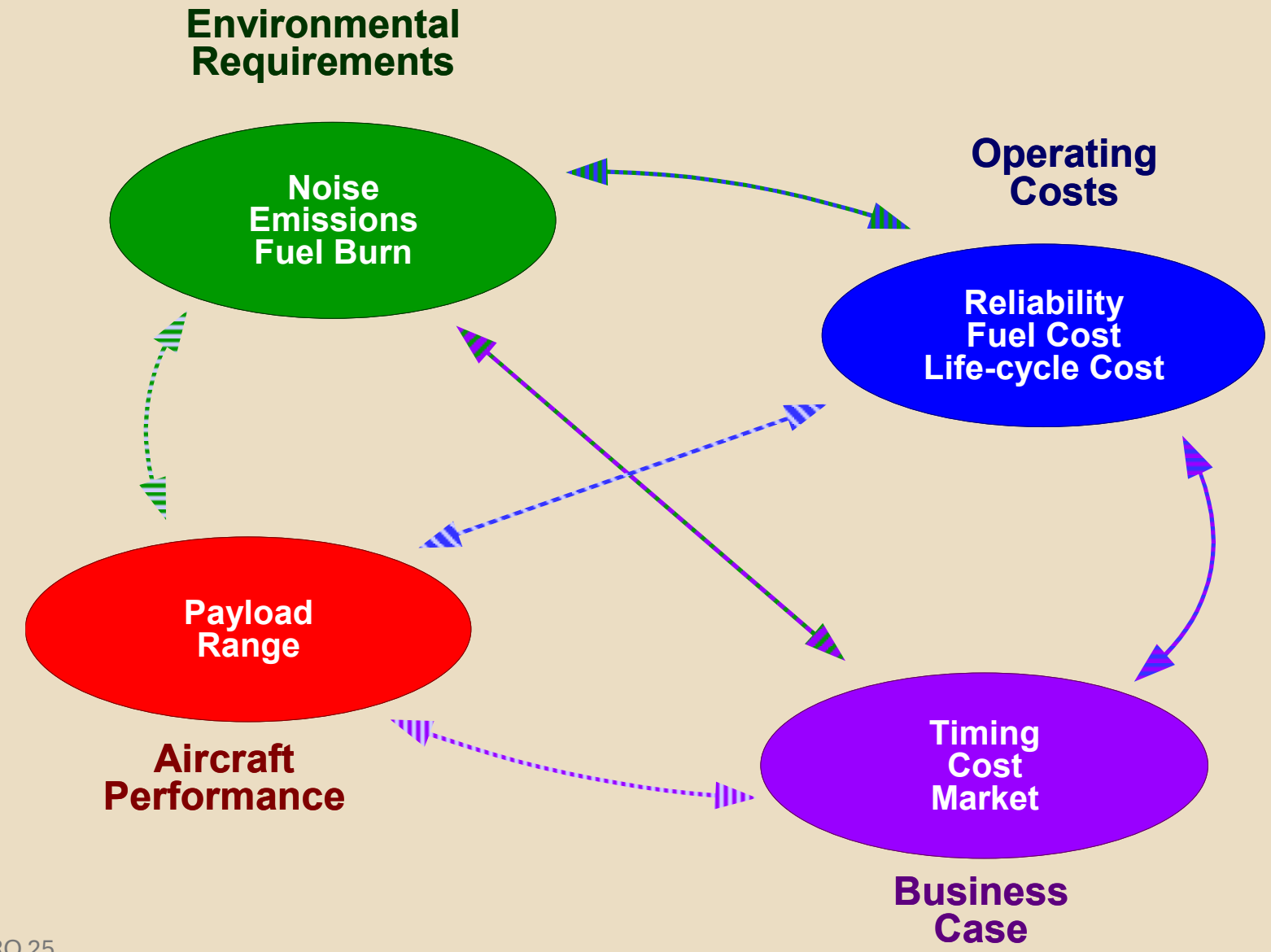



- Key systems property – a system is made of parts.
- Development of system requires regular iteration and integration: between solution and requirements AND between the layers



©RB Systems

# 3c) System Attribute Trade-offs




Taken from Beasley and Clifton, 2008, "*The Impact of Environmental Issues on Rolls-Royce Design Systems and Solutions*", INOCSE IS 2008

Note that the Business case issues set up for the next system – the one that creates the system

You don't just optimise the technical product – you optimise the cost / investment in developing it



©RB Systems

# 4a) Project / Program / Development System

## What is purpose of business / enterprise / project?

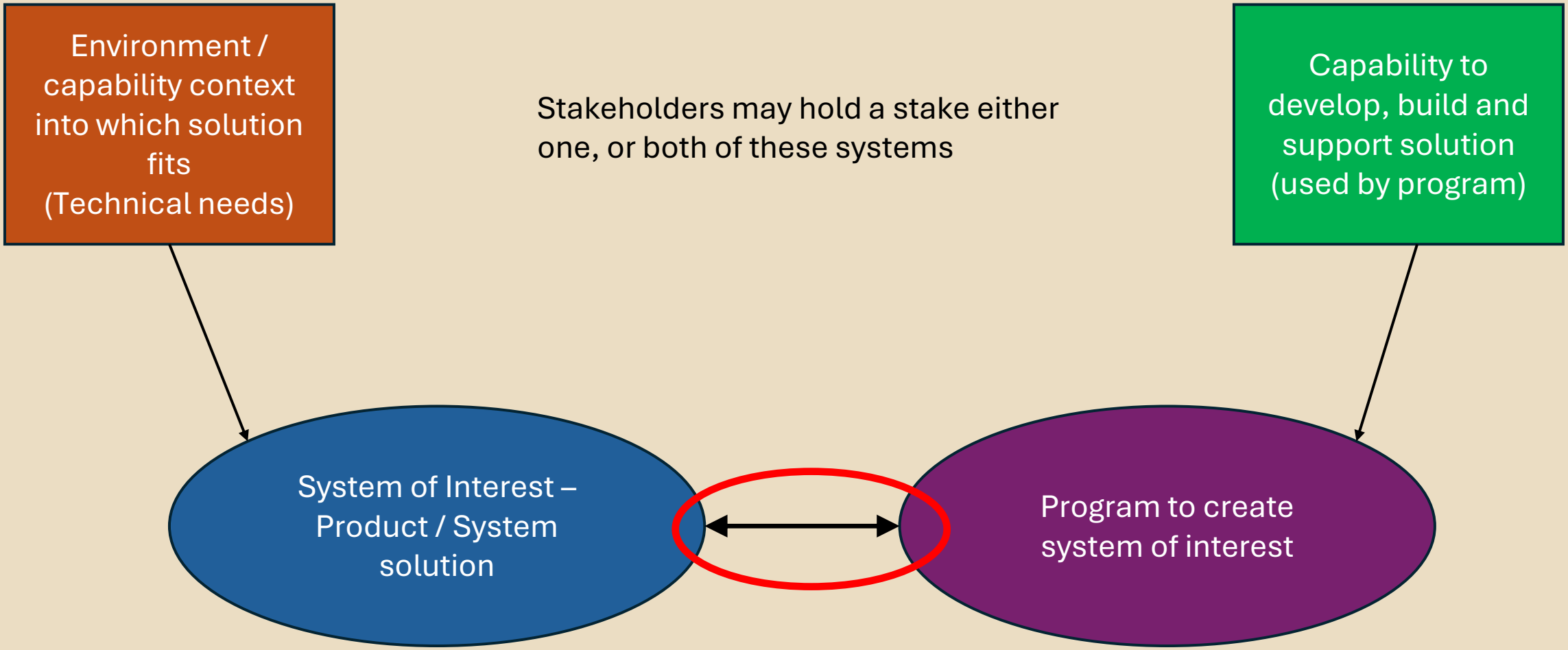
- This defines constraints on the project to develop the system different to the system's technical requirements
- These constraints are just as influential – solution has to be produceable within cost and schedule, and to meet business intent
- But plan must produce a solution that is valuable to the technical stakeholders!

## Functions of Plan

- Decide level of effort in all activities – to maximise value
- Coordinate and sequence all activities
- Plan, make and communicate decisions
- Manage iterations
- Assess and mitigate as appropriate risks (and opportunities)


©RB Systems

# 4b) Interaction Between Solution and Project

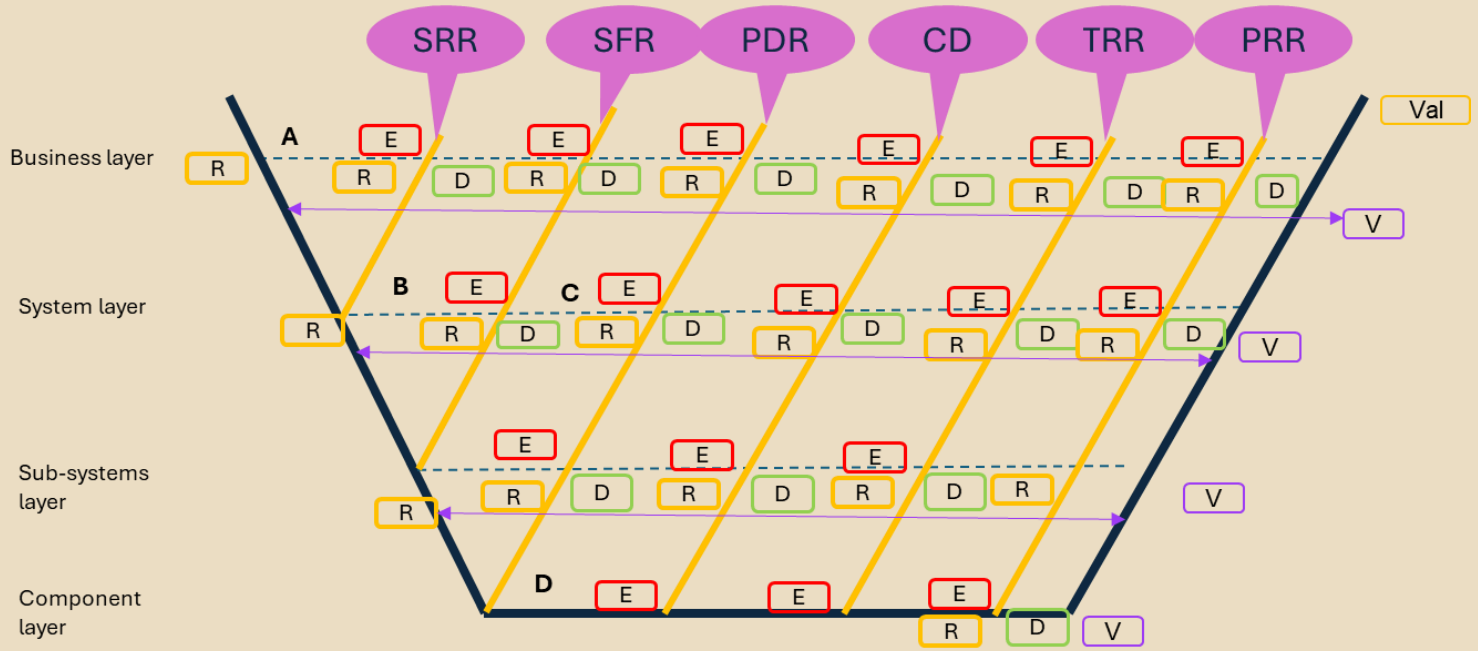



- This two-way interaction – flow of needs and constraints vital


©RB Systems

# 4c) Controlling (and Adapting) the Plan

- Solution development generate information and understanding (progressively)
- Need to decide appropriate level of effort
- Need to coordinate the development of that information
- Need to make decisions
- Need to replan based on those decisions

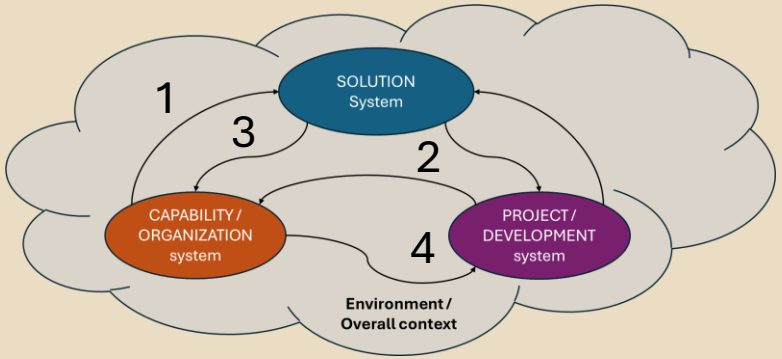



Derived from the Assurance V described in Scheithauer, D. and Forsberg, K., 2013, V-model views, INCOSE IS 13, Philadelphia PA, USA
Expanded in Beasley, Cardow, Pickard, 2018, Requirements Management or Assurance Management? Keep the data integrated, INCOSE IS 2018, Washington DC, USA

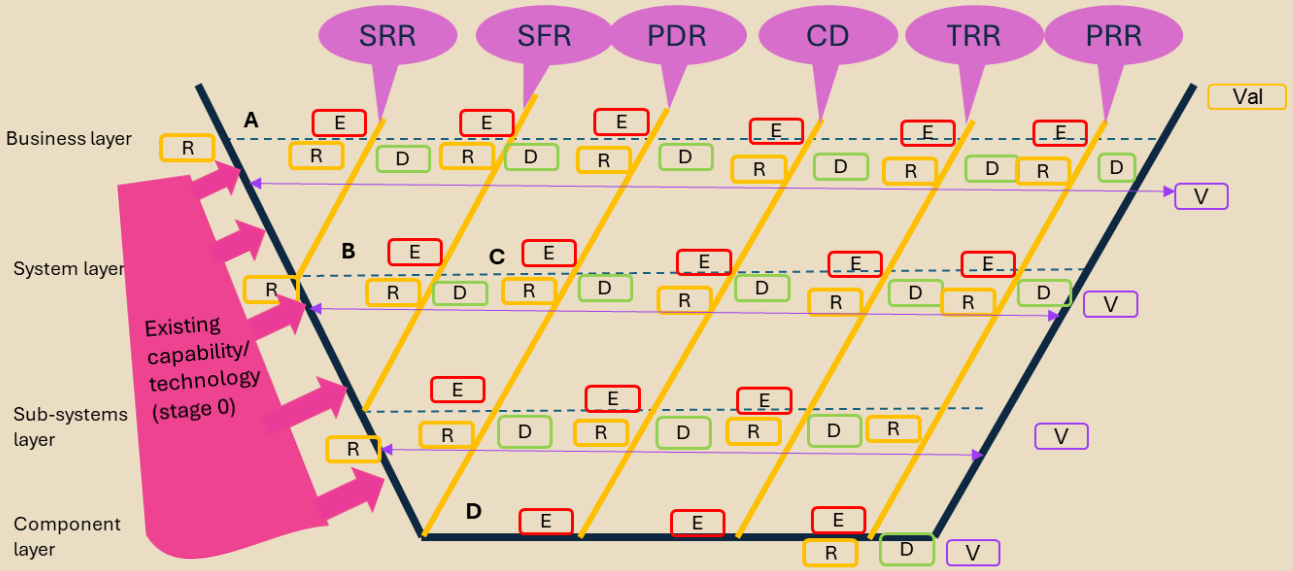


©RB Systems

# 5a) The “System of Innovation” - Capability




1. Existing / likely capability defines the potential solution options
2. Program / business constraints and needs define how much new capability can be developed
3. Solution development creates greater clarity on capability needed
4. Program has to use the capability that is actually developed (not just assume it gets what it wanted!)






©RB Systems

EURO2025 LEEDS

# 5b) Capability Chessboard

| | Lifecycle phase | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Capability element** | Plan / Manage Prog | Prelim concepts / R&T | Determine Reqm'ts | Generate Solution | Verify Solution | Produce Solution | Support Solution | Manage Capability |
| People | | | | | | | | |
| Technology | | | | | | | | |
| Tools | | | | | | | | |
| Process | | | | | | | | |
| Knowledge | | | | | | | | |
| Supply Chain | | | | | | | | |
| Facilities | | | | | | | | |
| Organization | | | | | | | | |

This "chessboard" acts as a prompt for capability needed

Developed from
*"The Capability to Engineer Systems is a System Itself!"*,
Beasley, R., and Pickard, A., 2020, INCOSE IS 2020



©RB Systems

# When did they make this adjustment to the hangar?




Doors of C-17 Corrosion Control Hangar at Hickam Airforce Base on Oahu

Image from C-17-FCND-Hangar-Door-Closed-1920x800.jpg (1920×800)

EURO2025 LEEDS

# 6b) Some Use Cases to Stretch Capability

## a) Consider

- A new technical requirement / attribute eg
  - Environmental challenge / pollution
  - Cyber-security
  - Resilience

## b) Transition / change of scope of supply

- From product supply (OEM) to service



©RB Systems

# 6c) Different “optimisation” challenges

**Solution**

Optimise at the system level

- Not at sub-element
- Not a single attribute over the others

**Project**

Balance product and project

- A poor solution on time and cost is poor and will cost to fix
- A high-quality solution late / over cost is a failure

**Capability**

Balance waiting to develop versus learning on the job versus accepting constraints due to lack of capability

Treat capability improvement as investment not overhead?



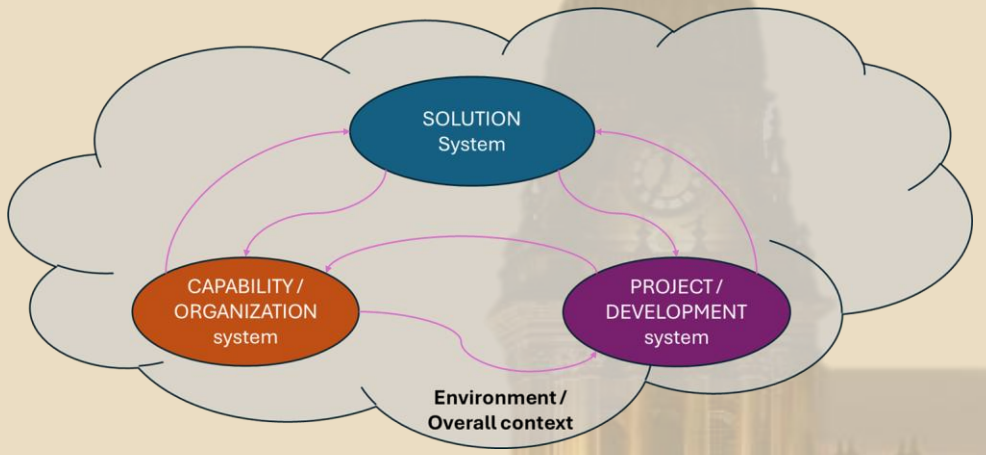
©RB Systems

EURO2025 LEEDS

# Questions / Discussion

Richard Beasley

richard@rbsystems.net




Celebrating the 50th Anniversary of EURO

UNIVERSITY OF LEEDS