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The Whole Nine Yards of Systems Engineering

Stakeholders and Enabling/Realization Systems

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Authors

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- Identifying Stakeholders
- Flowing Out Needs (to Everywhere)
- Systems to Consider When Creating a System
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Introduction

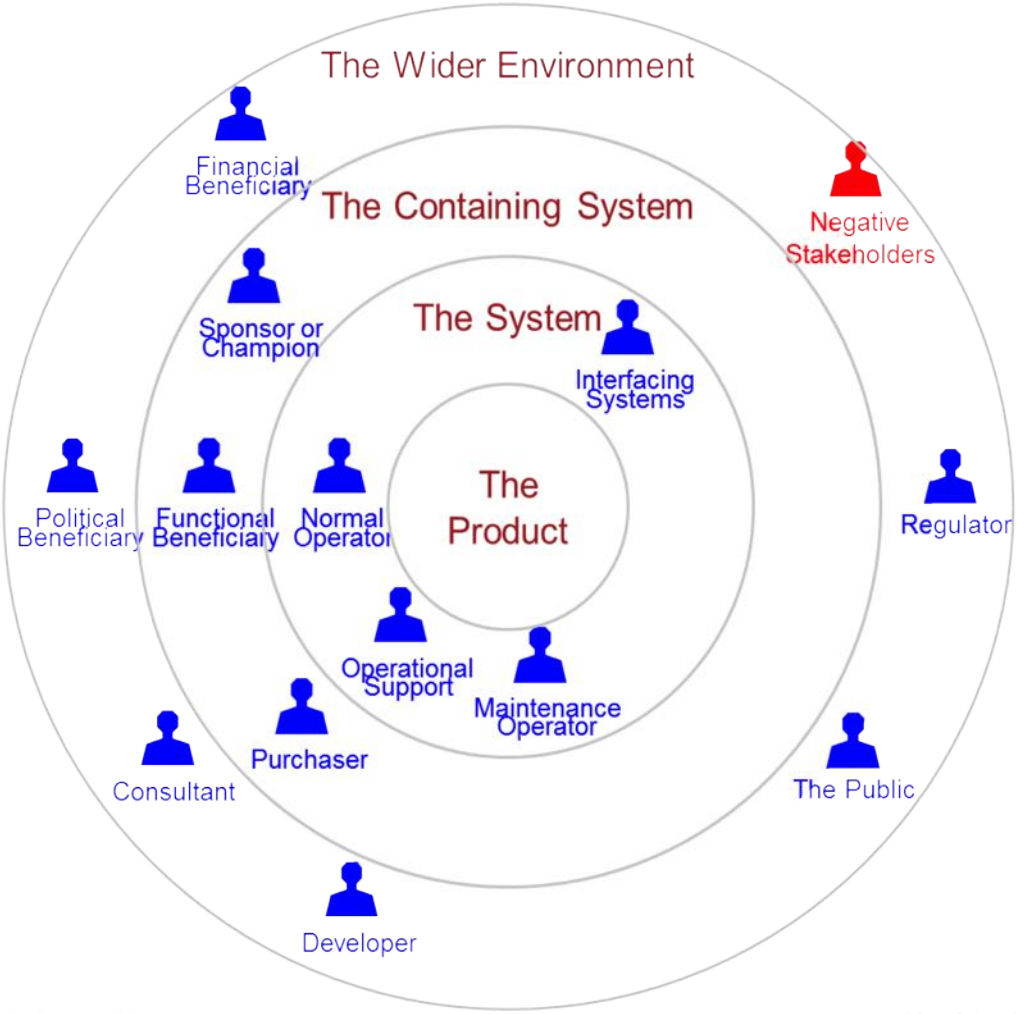
What is the issue?

- Systems Thinking is an “Engineering Essential” in Rolls-Royce.
  - A starting point is understanding the system that is your particular System of Interest and those other systems with which you have a relationship
- We want our integrated product teams for every system level and element to:
  - Understand their stakeholders to obtain **all** constraints (i.e. requirements)
  - Not be a victim and wait to be told what the requirements are
  - Be able to flow out their needs to **any** relevant system upon which their solution depends
    - This is not only the lower level elements
- This builds on the work of James Martin and the paper he published in 2004 on “The Seven Samurai of Systems Engineering”

Stakeholders

- Integrated Product Teams that design systems elements need to understand who their Stakeholders are, and hence know all of the constraints on their particular system
- This implies that the Design Team for each system element must elicit a complete set of needs from the stakeholders for the system element
  - This is not just “the System above” the system element
  - The stakeholder onion model is a useful guide to identifying the stakeholders for any “system”.
  - It also helps understand the influence of each stakeholder, and hence leads to an appropriate stakeholder needs elicitation approach for each stakeholder.
  - This is supported by section 4.1 of the Systems Engineering handbook – at every level there are multiple stakeholders.

Range of Stakeholders



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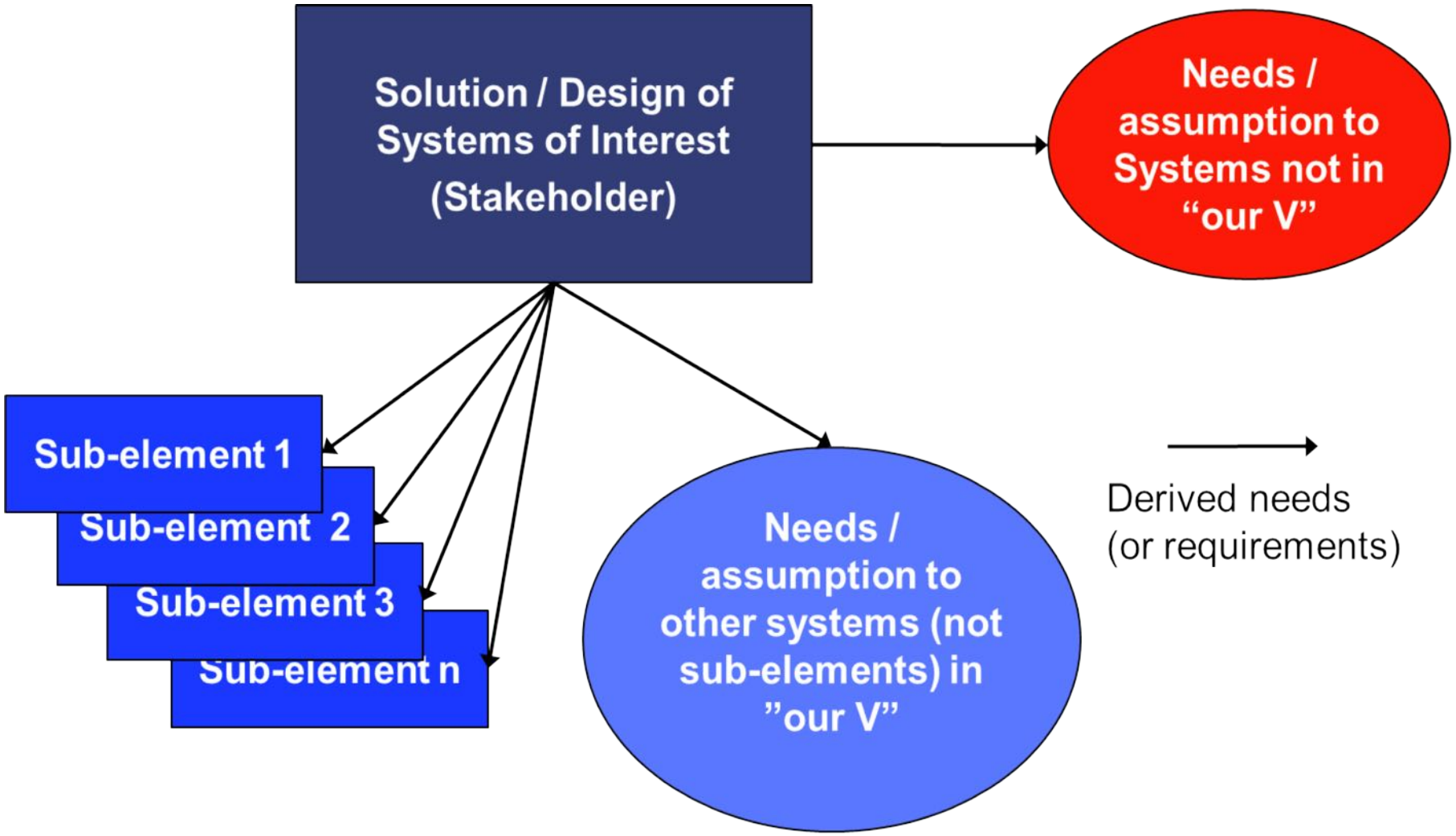
After © Ian Alexander 2006

Flowing Out Needs

- Integrated Product Teams that design systems elements need to flow out their needs to any other relevant systems on which their solution depends
- Understanding how to be a stakeholder for other elements in or needed for the system covers the systems thinking required for the structure of systems. There are two elements:
  1. Derived needs for other elements in the system - both the sub-elements that come from the architecture of the solution system (which is relatively well understood, if not always practiced), and other elements due to the coupling in the architecture. (Things in your V).
  2. **The particular subject of the remainder of this paper, is the relationship between the solution (in our case a product / service / business based around a power and propulsion system) and the "infrastructure" / realization systems that enable it to be created / built/ delivered etc. (Things not in your V).**

Flowing Out Needs

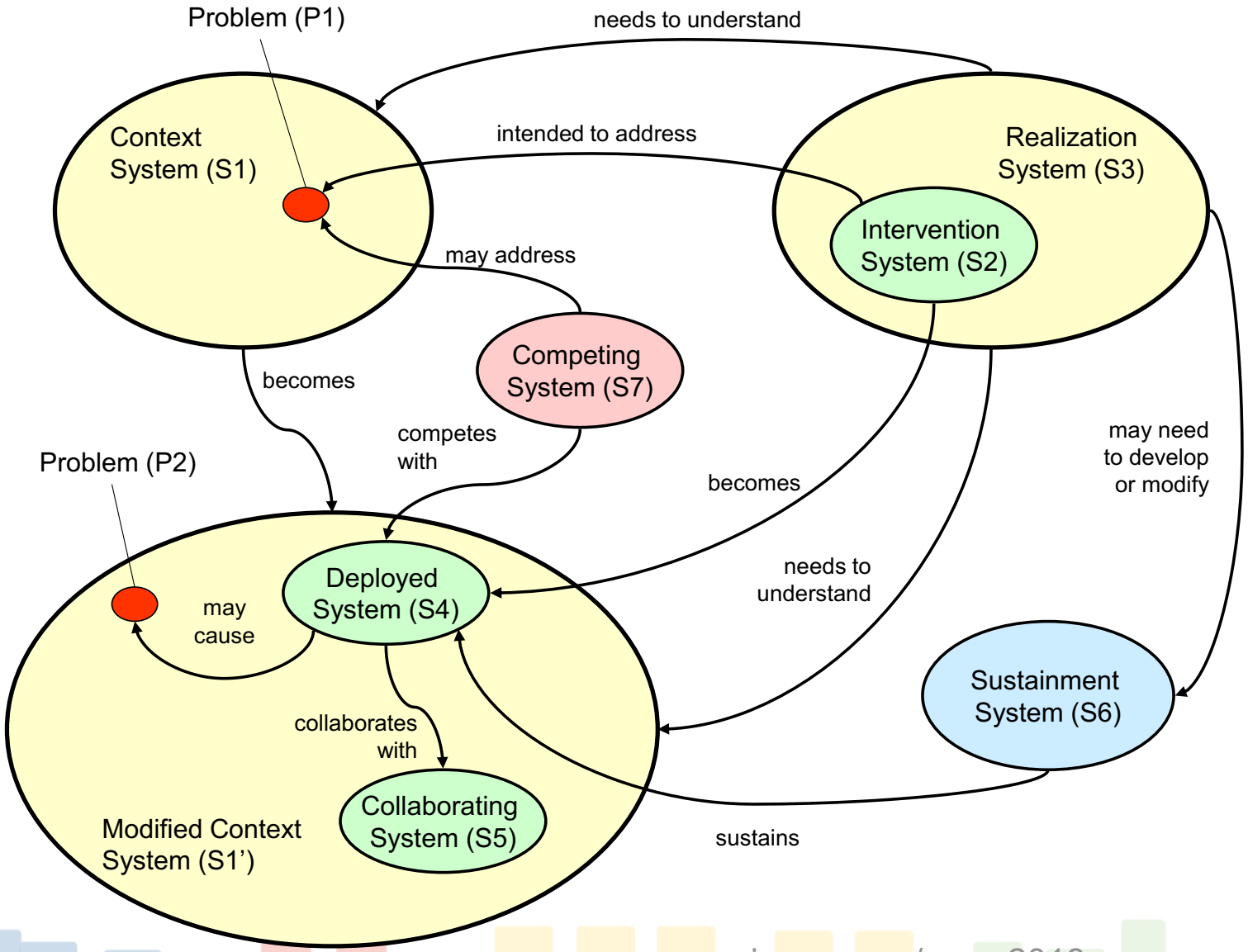


The Nine Yards

- We are going to show you:
  - The original “Seven Samurai”
  - The Context/Opportunity
  - The Solution in relation to the Context
  - The Realization Systems that the Solution needs*
  - The Business Execution System that controls the development of the Solutions*
  - The Business Unit System – Integrating Realization Systems*
  - Layers of Business Units*
  - The Whole Nine Yards

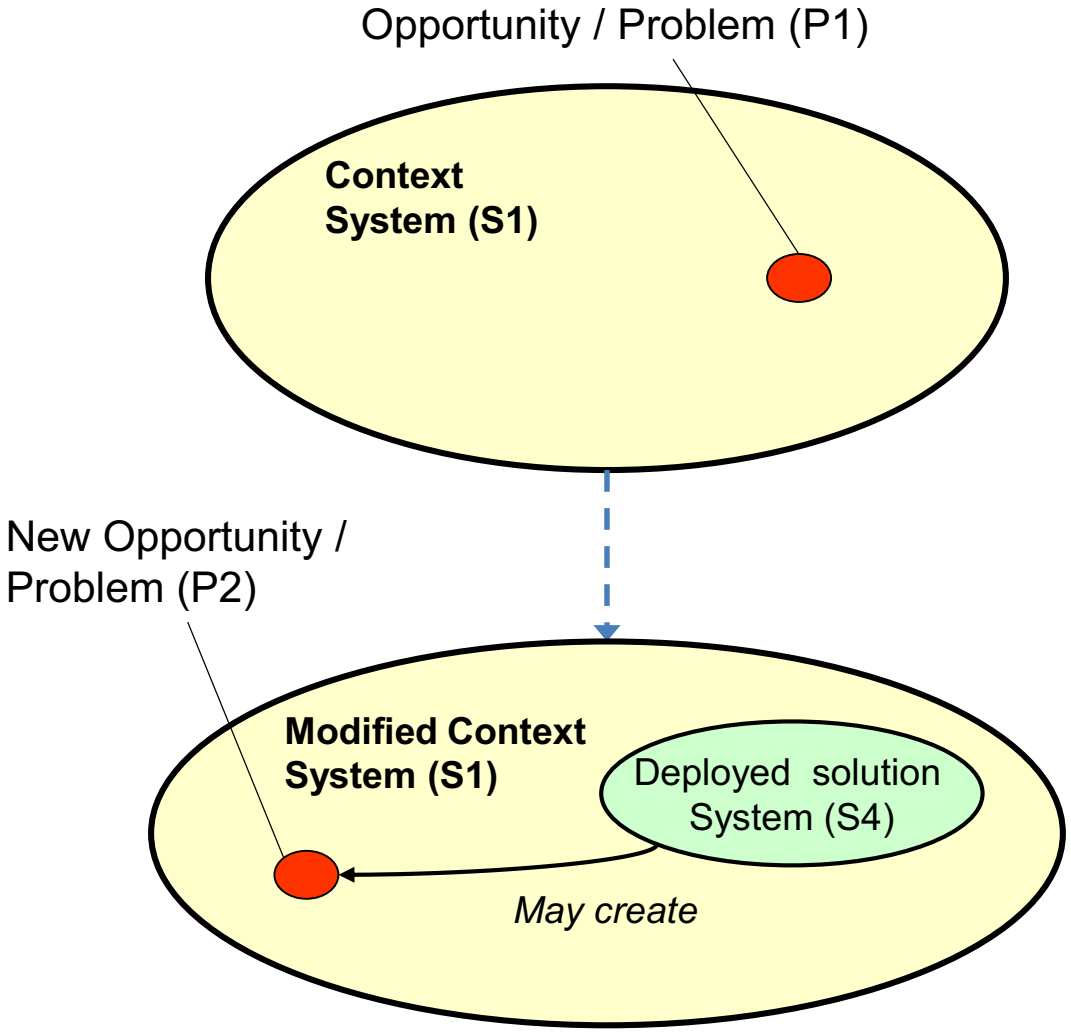
* These are the variants to the original “Seven Samurai”

The Original “Seven Samurai”

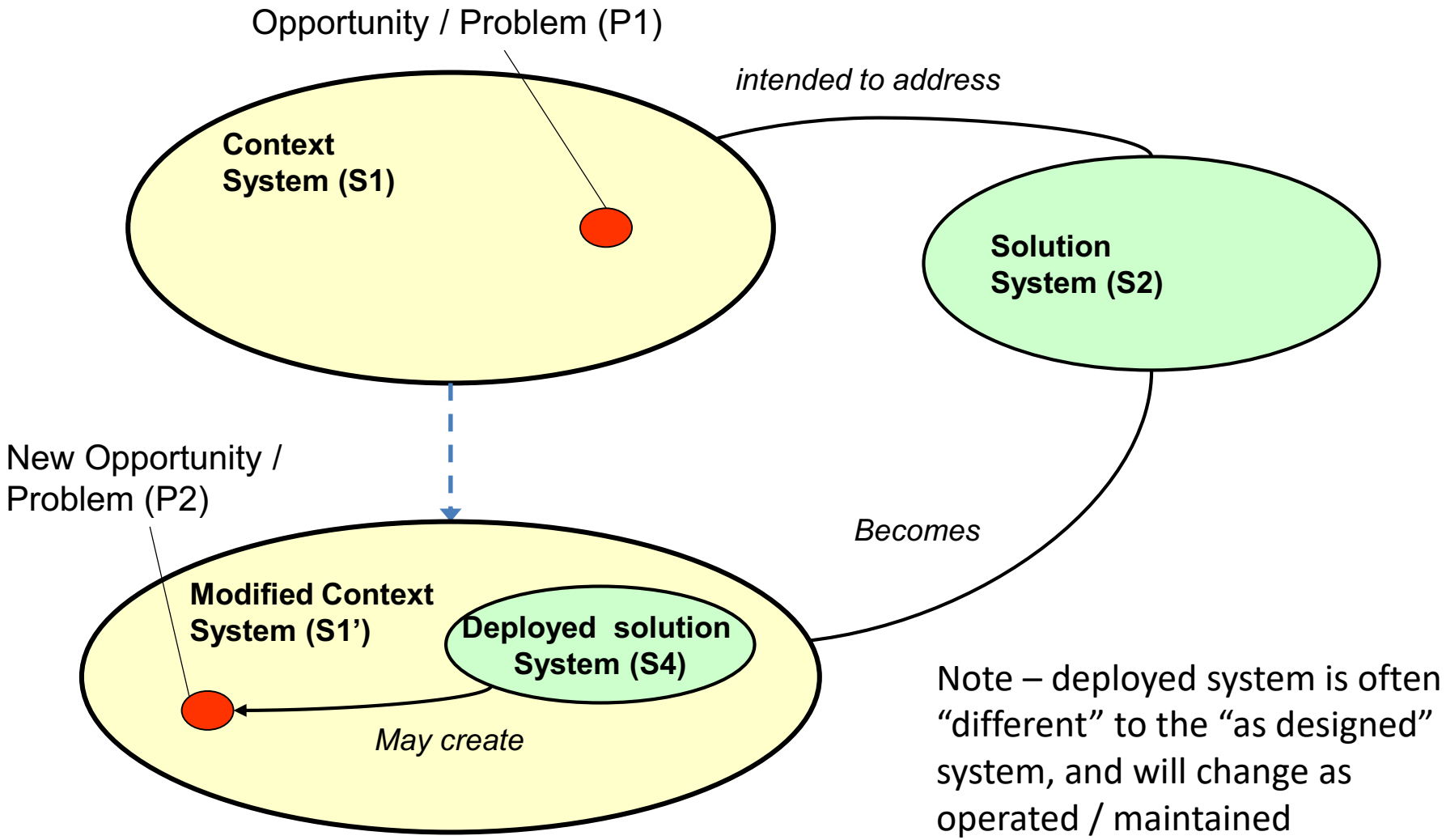


From Martin, 2004 The 7 Samurai of Systems Engineering

The Context/Opportunity

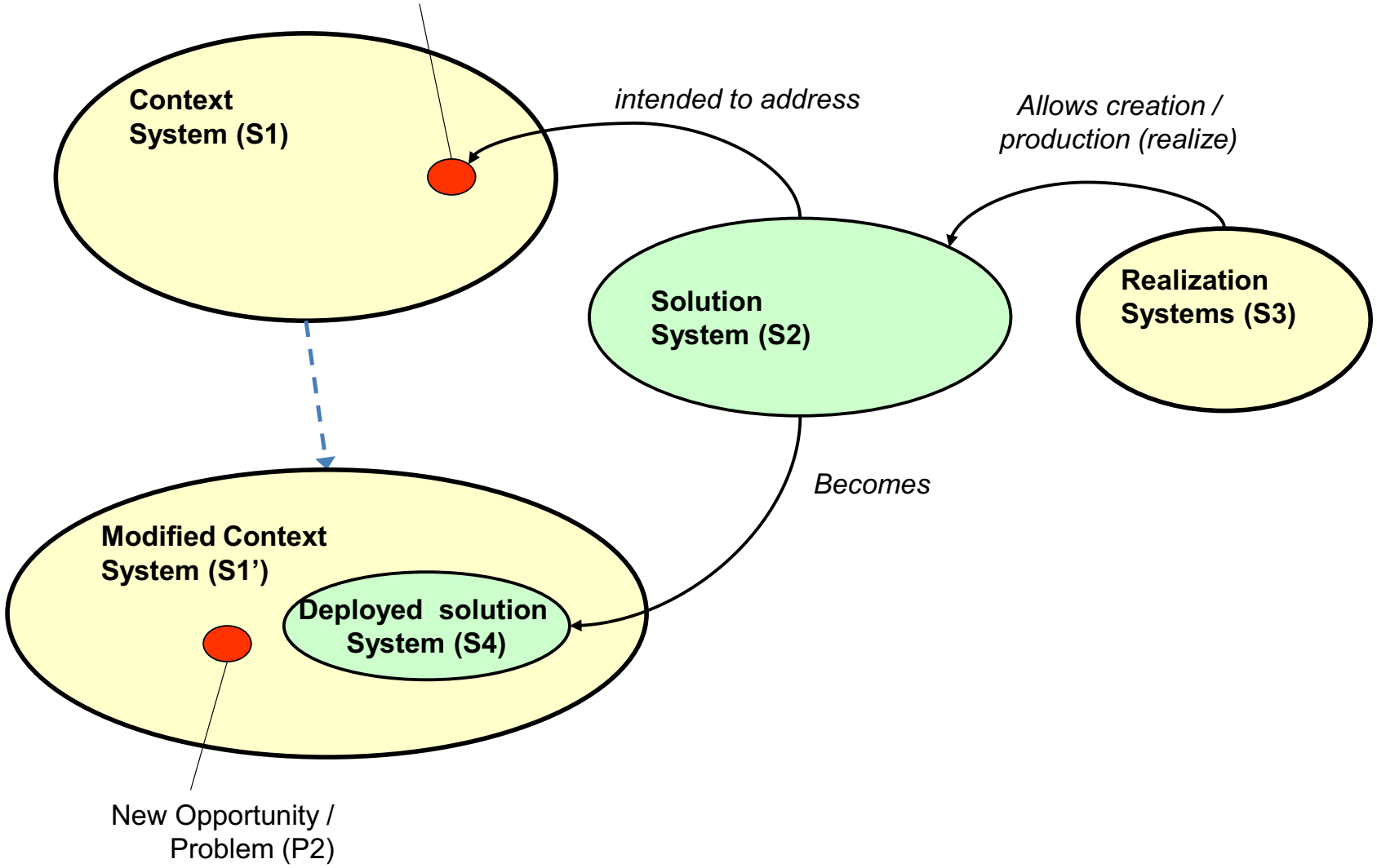


The Solution in relation to the Opportunity



Note – deployed system is often "different" to the "as designed" system, and will change as operated / maintained

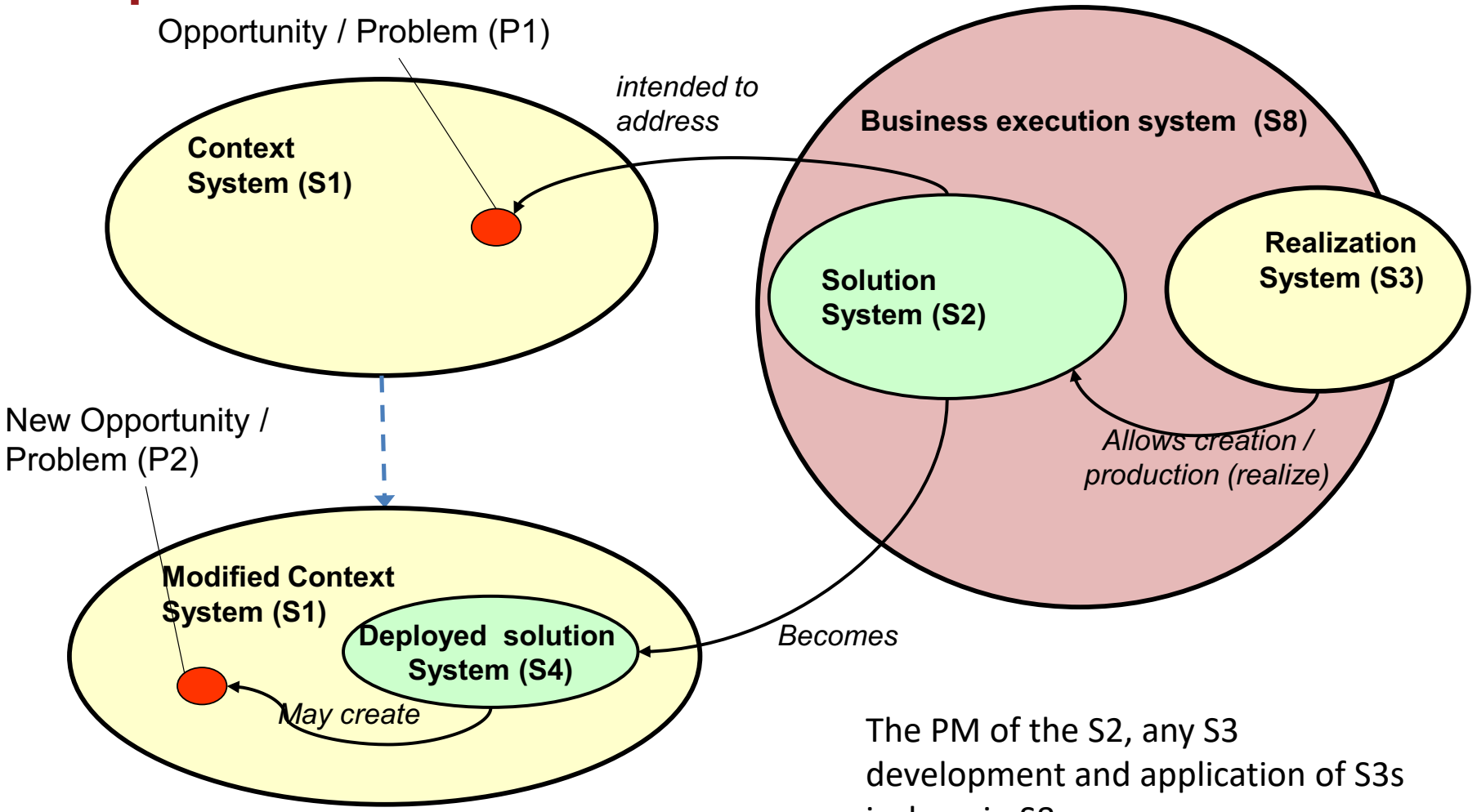
The Realization Systems that the Solution Needs



Relationship between Realization Systems and Solution

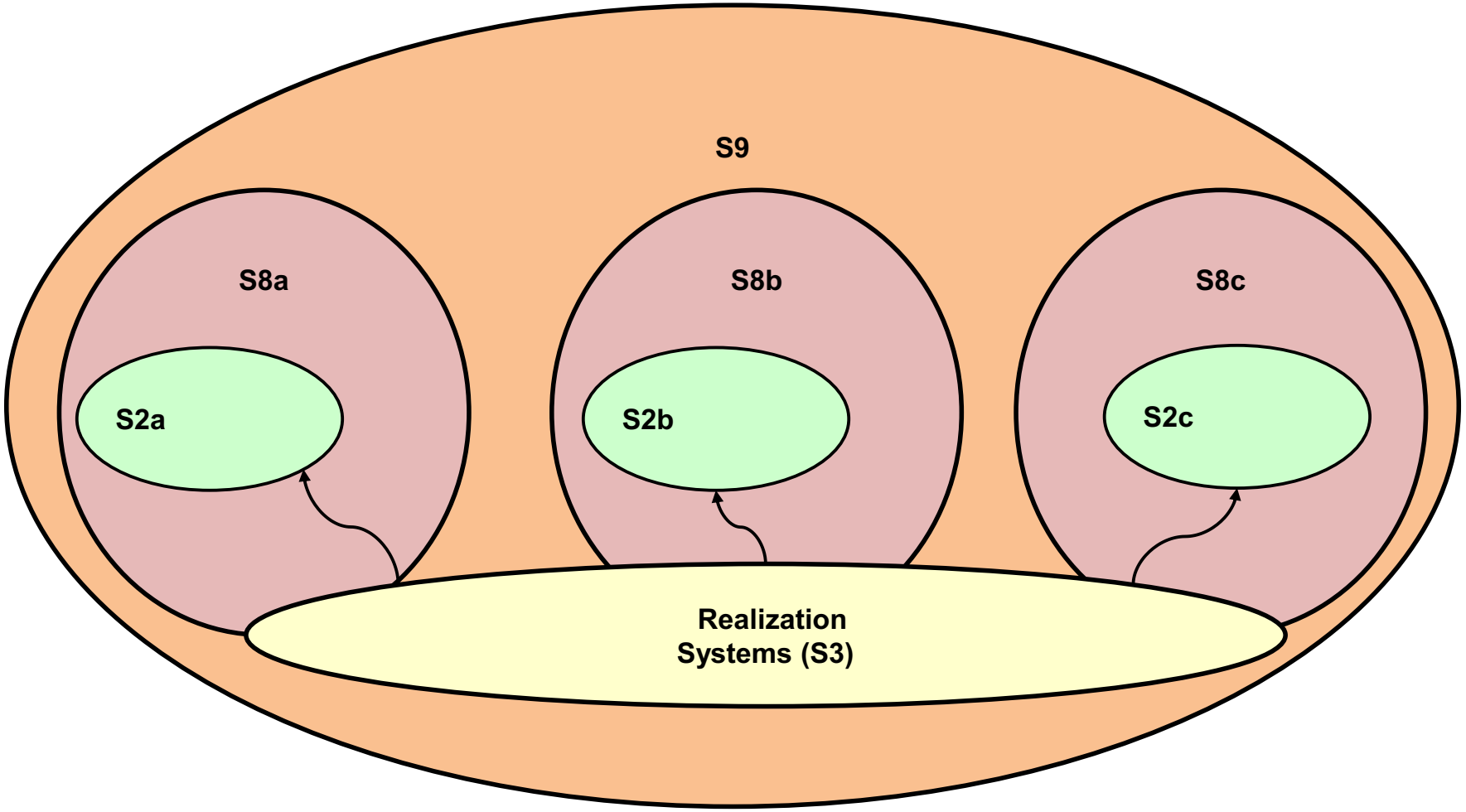
- Here they are shown as on the same level
  - Martin had Solution as a sub-set of Realization System
- A key issue is how the needs of the Solution get to the Realization Systems (and vice versa)
- Even if the Realization Systems exist, they need to be allocated to the Project producing the Solution
- Most organizations produce many solutions and the realization systems are a shared resource for them all
- Hence the need for a separate “Business Execution” system coordinating activities

The Business Execution System that controls the development of the Solutions



The PM of the S2, any S3 development and application of S3s is done in S8

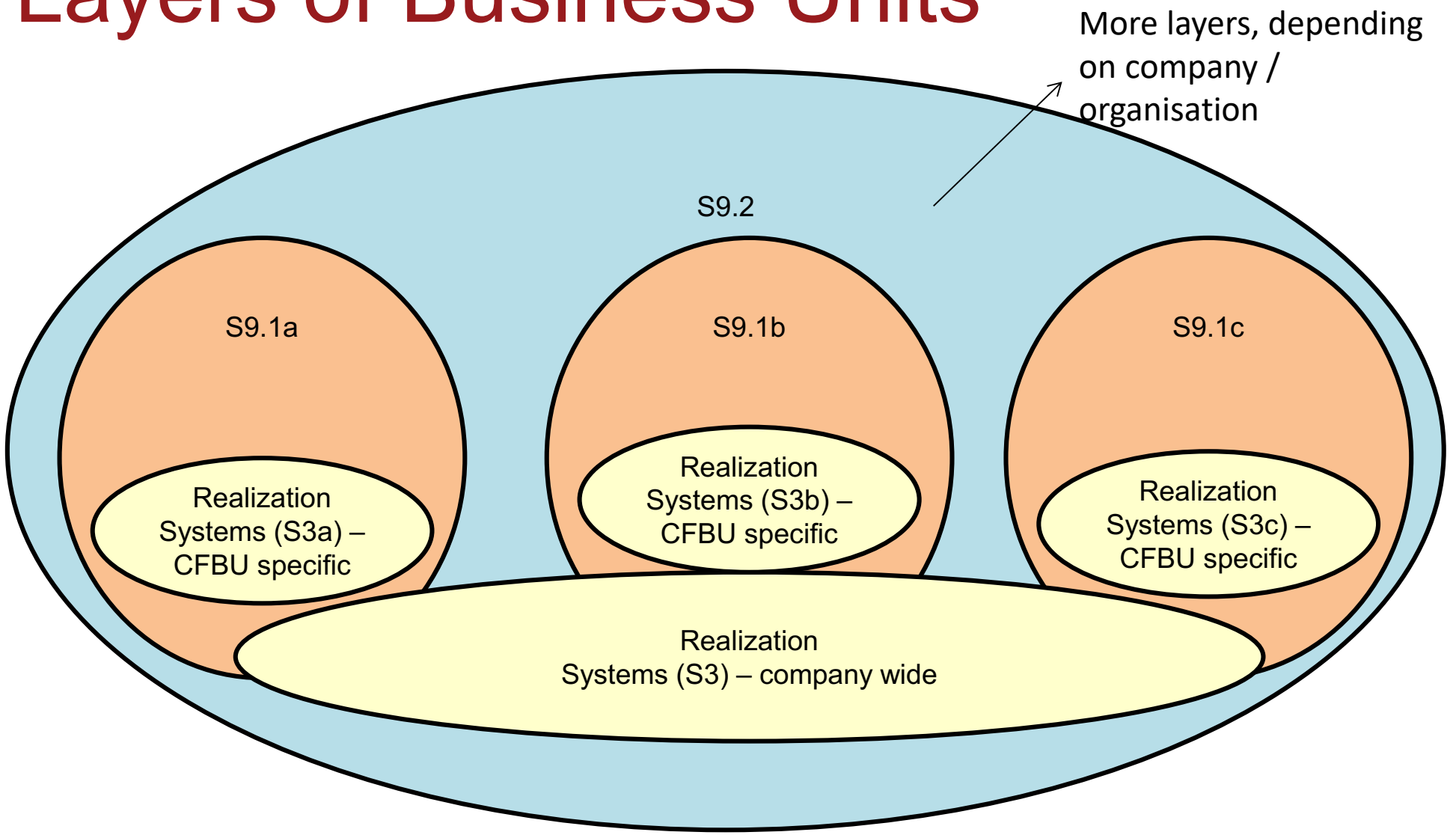
The Business Unit System – Integrating Realization Systems



How Many Levels in the Organization?

- Every Business Enterprise is organized differently
- It is not unusual for there to be different Divisions within an Organization
  - Either producing similar Solutions or focused on a particular Domain
  - Or focused on particular Customers
- The Realization Systems may be specific to one Division or shared Corporately
  - We assert it is the exception for a Realization System to be specific to one Solution
- Therefore the Enterprise System may have several levels

Layers of Business Units

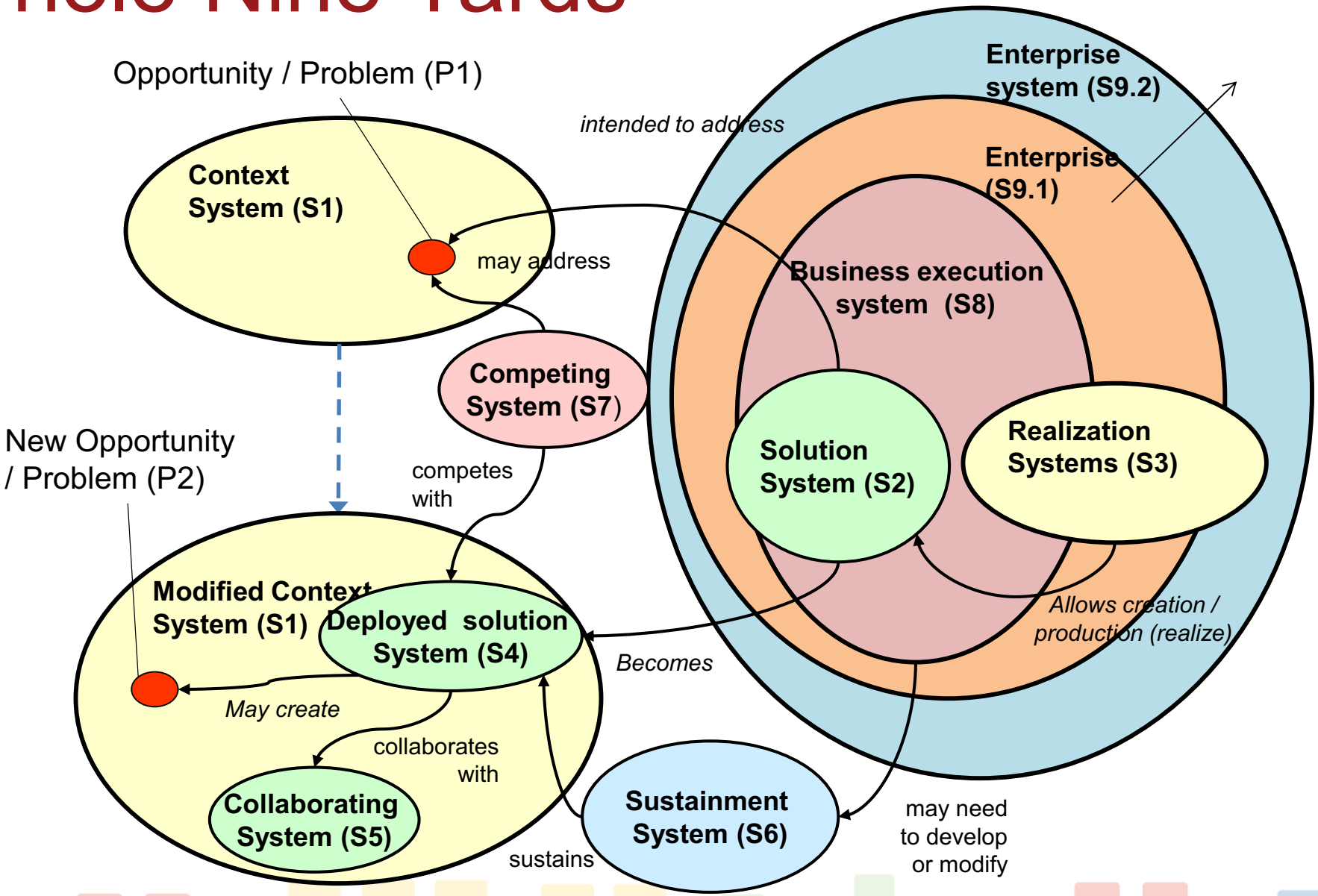


Coincidentally, this mirrors the current Rolls-Royce organization of

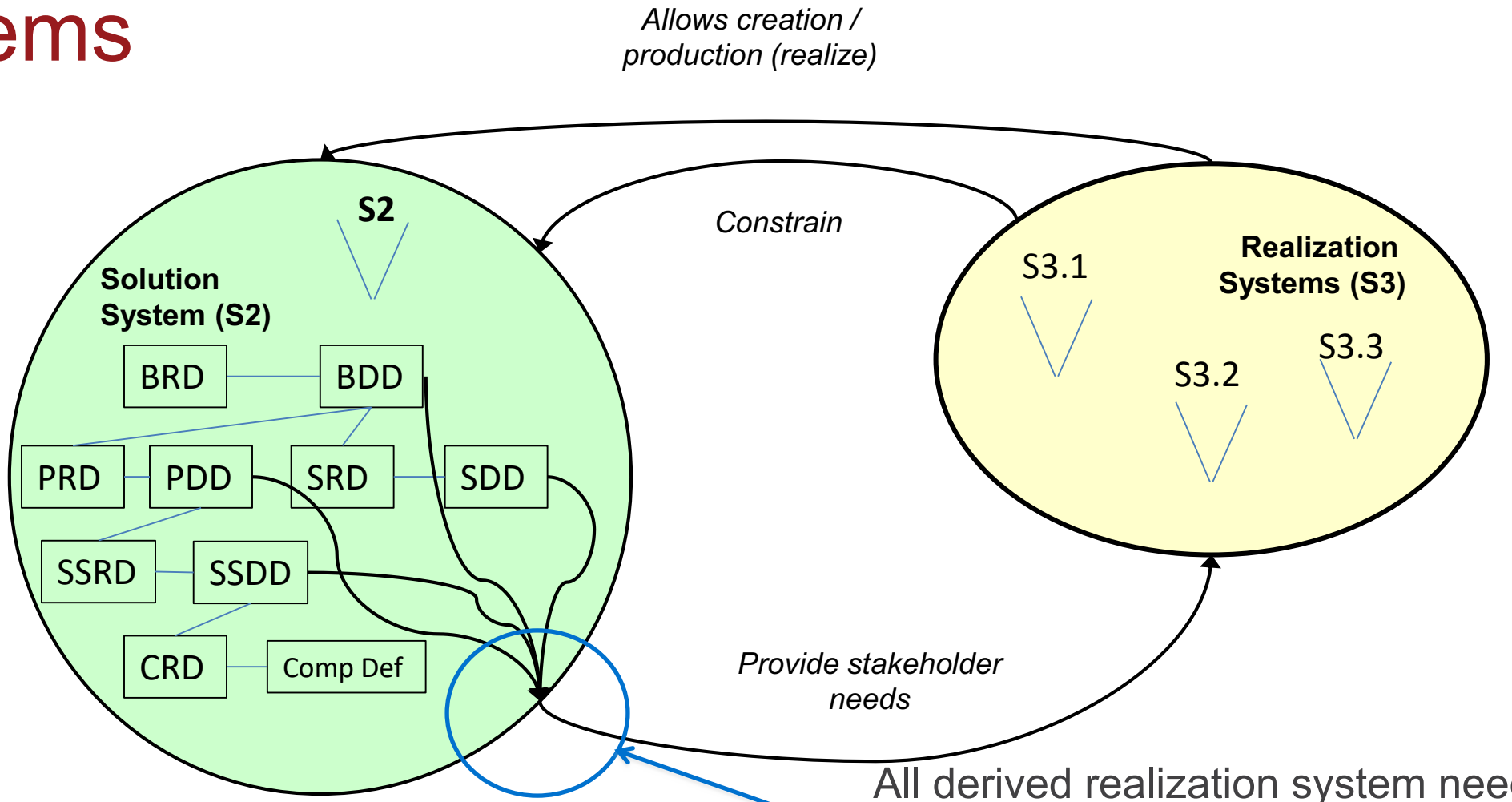
- Civil Aerospace
- Defense
- Power Systems

N.B. CFBU = Customer Facing Business Unit (Rolls-Royce Terminology)

The Whole Nine Yards



Relationship between Solution and Realization Systems



All derived realization system needs have to be coordinated by the Business Execution System lead

Examples of Realization Systems

- Secure Infrastructure – access control, separate IT networks, extra secure tracking and storage of documents and parts
- Partnership between two or more Organizations to create a Product – division of responsibilities, communication protocols, decision management
- Design Analysis Tools - these are typically common to the enterprise, and introduction of a new tool is coordinated across the enterprise
- Facilities used to make the system – the factories for the components, the assembly shops for the whole, and all the test facilities.
- Part of the solution provided by Rolls-Royce is service of the product. To support this a series of Service Operation rooms have been created. These are systems in their own right, and are generally for the range of products (fleets) produced by a business unit
- The sales team – to achieve the specific business intent of the solution a requirement for sales (price), volume and timing is created from the business model. However, there tends not to be a specific sales team for a given solution. Instead the sales teams are organized around specific customers and / or geographic regions – so sales campaigns can be integrated and optimized for the benefit of the whole business rather than specific projects.

Impact on Modeling Practice

With many systems involved in the creation of a solution:

- What is the problem to be modelled?
- How are these models to be connected?
- How do the systems influence each other?

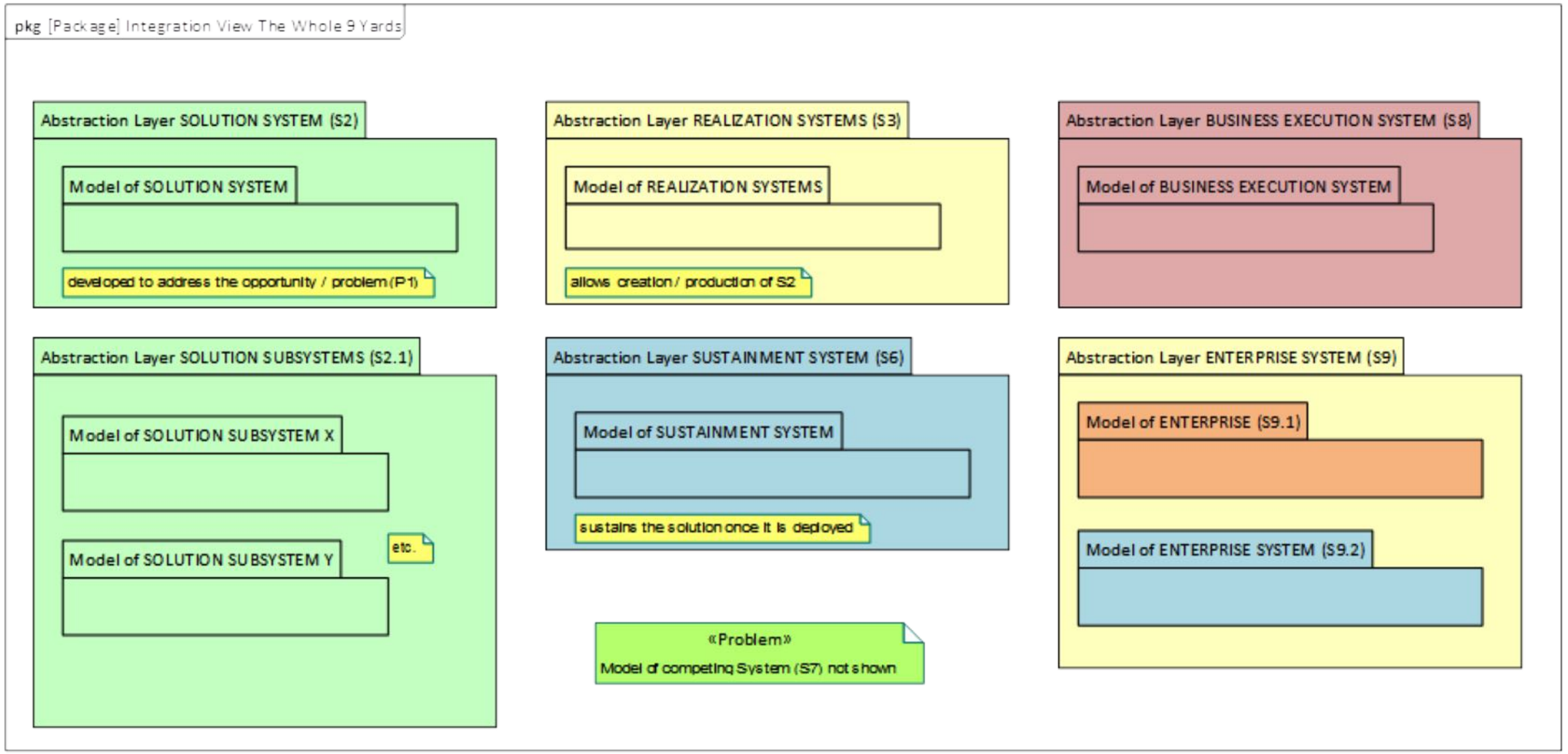
Can we use Abstraction Layers to help?

- Typically Environment > Enterprise > System > Sub-System > Component layers
- Typically modelled as separate but loosely coupled models
- Meta-model of the “Whole 9 Yards” model

Understanding the requirements of the Solution System will determine requirements on the other elements of the realization system

- Hence there will be relationships between the requirements and solution models for each of the realization systems
- Hence the models of the realization systems need to be shareable across the enterprise

Impact on Modeling Practice



Conclusions

- The Systems Engineer is a stakeholder for the realization systems (S3).
- The Program Manager has to sit in the Business Execution system (S8).
- Model management and information flow between models should be considered early in a program.
- Apply SE to the creation of the organization that embeds and practices SE as the means of producing successful outcomes (the way we work).
- Even if the solution system is “merely” complicated (and so a single system / V) the organization to produce it is certainly complex.
- An enterprise set up to manage just one product is a special case.
- The realization system becomes the “solution” when creating or modifying a realization system.

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