Top-down Meets Bottom-up

Experiences in Integrating Existing Components in Transport Systems

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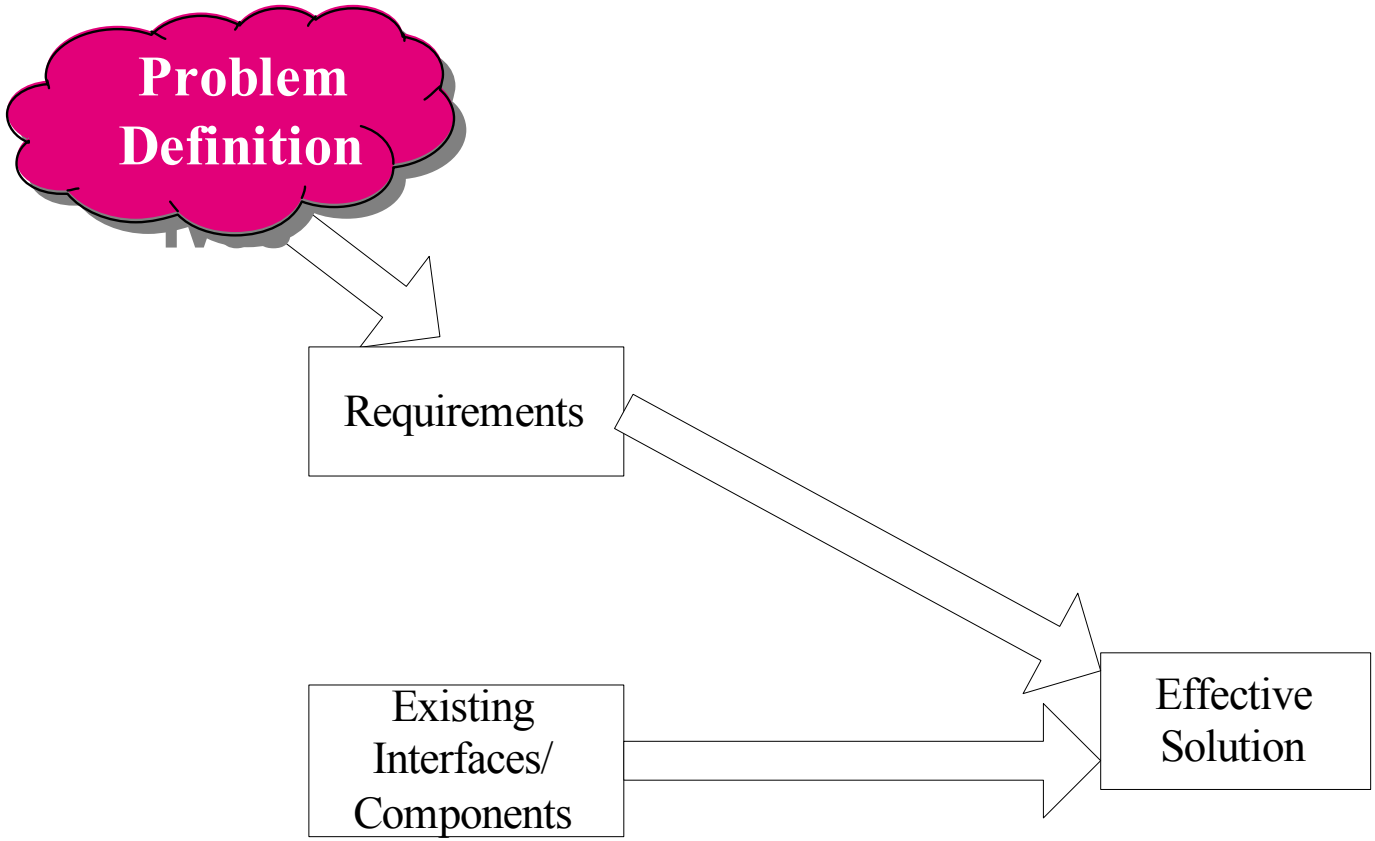
Background

- Procurers want more, for less, quicker
- Not cost-effective to keep starting from scratch
- Instead start from what is available
- Conflict with classical top-down approach:

  ➔Requirements -> design -> development -> commission

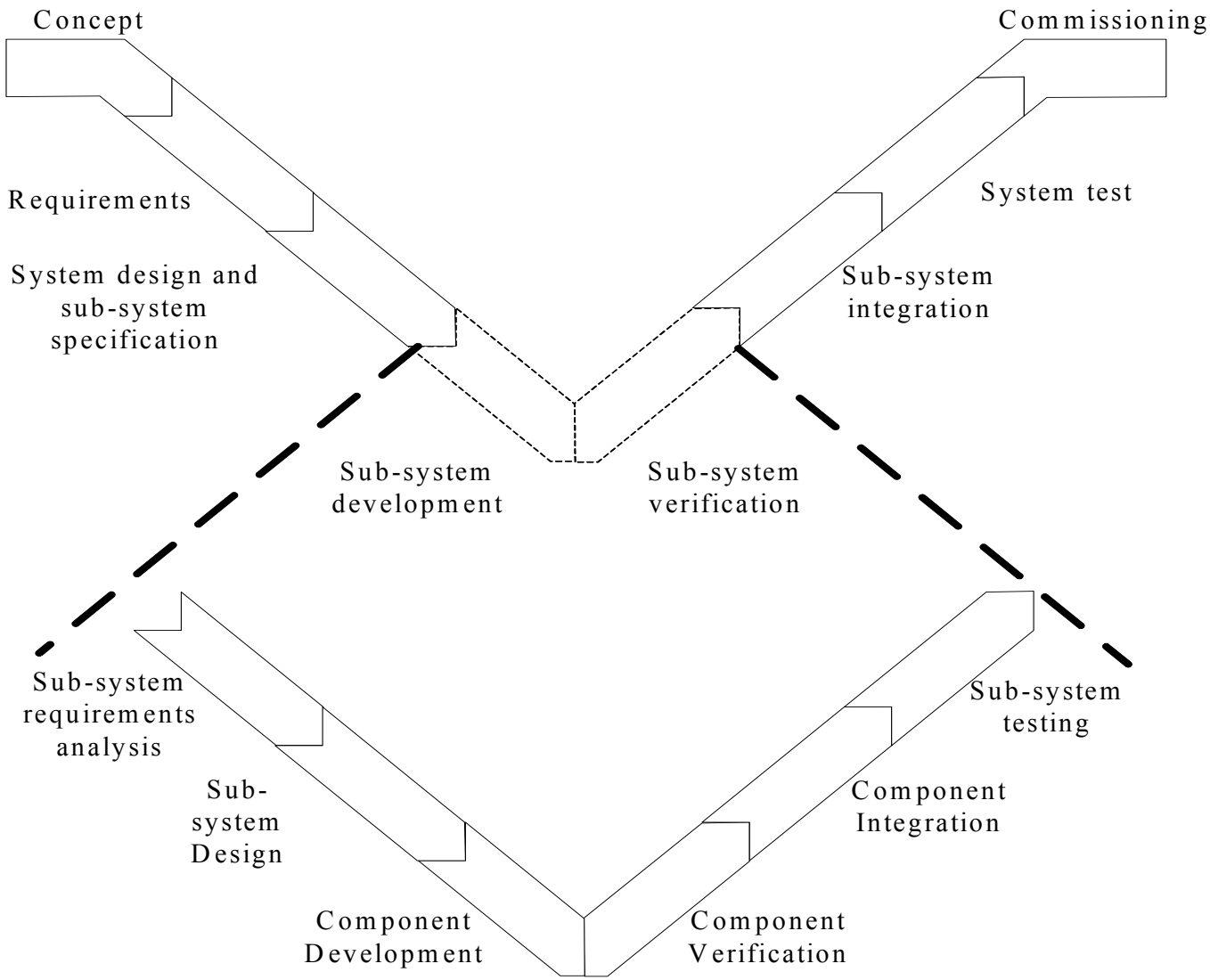
How best to get to optimal solution?



Top-down (1)

- Classical Approach
- Requirements driven
- Sequential activities
- Difficult to react to change
- Produces working solution
- Slow
- Working solution may not be right solution

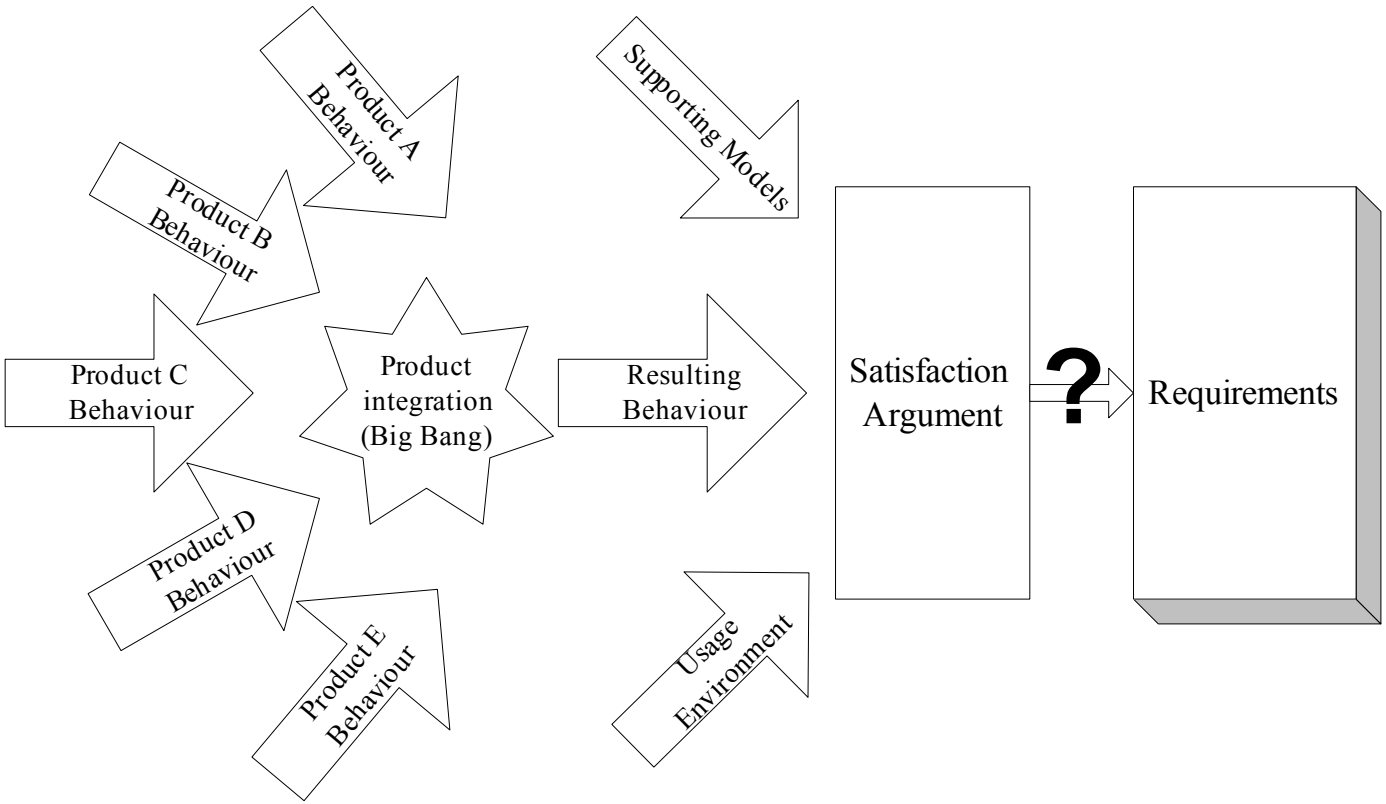
Top-down (2) – System and subsystem V model



Bottom-up (1)

- Driven by available products/components
- Cheap (or appears so initially)
- Interoperability problems
- Limited by products available
- Certification difficulties if new application

Bottom-up (2) – but are the requirements met?



Case Study 1 (1) – Context

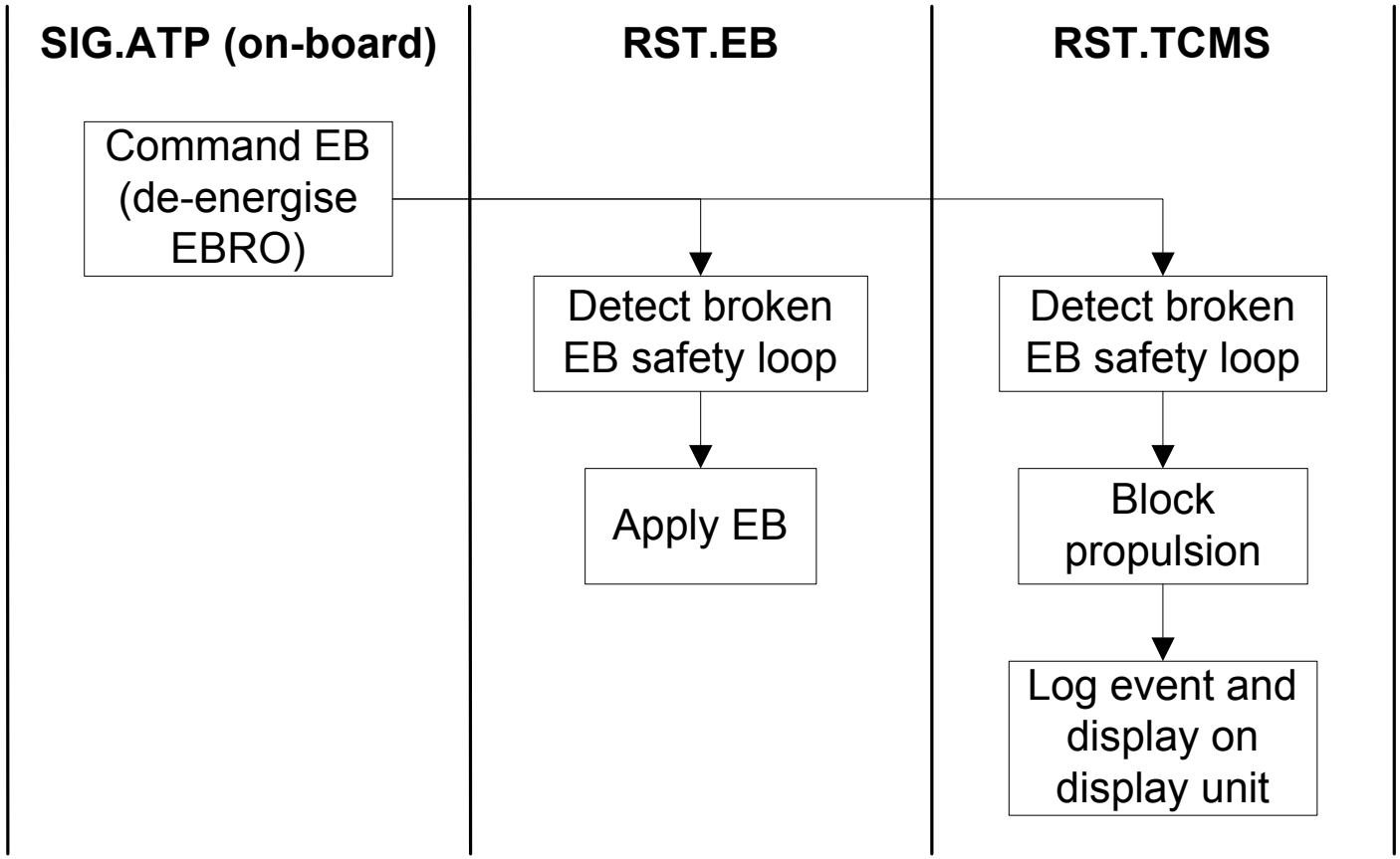
- Express/Commuter line in South Korea
- Suppliers selected and contract let
- Contract based on very detailed 'requirements'
- 'Requirements' baselined but changing
- System behaviour not explicitly defined
- Differing culture and engineering style

Case Study 1 (2)

- Goal: reduce procurement and integration risks
- Approach:
  - ➔Define system functions
  - ➔Define subsystems responsible for delivering each function
  - ➔Where more than one subsystem involved, define how subsystems work together to deliver the system
  - ➔Update subsystem functional specifications and interface specifications where necessary

Case Study 1 (3)

Function: Emergency Brake (EB) triggered by ATP

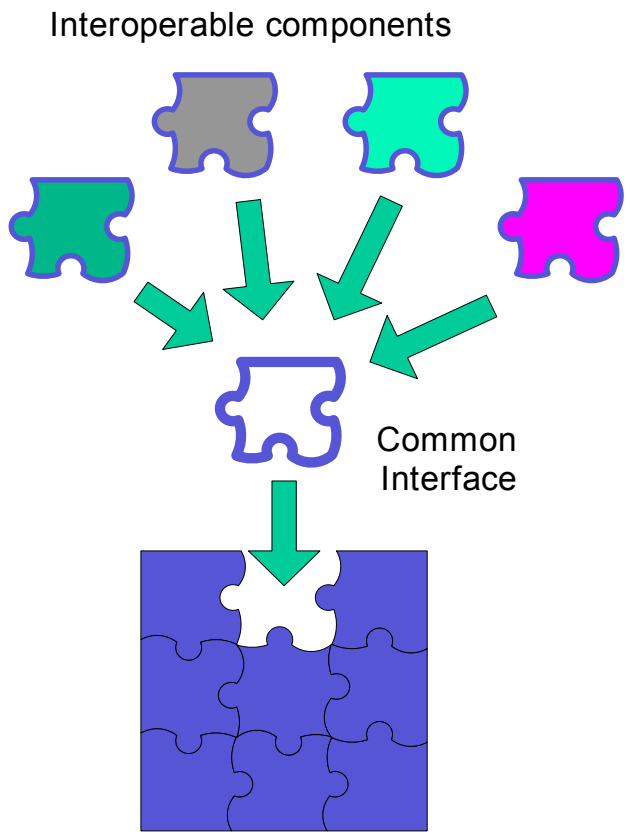


Case Study 1 (4) - Benefits

- More confidence that specs for subsystems specify the functionality required
- More confidence that required interfaces will be provided
- Improved communication and understanding of system behaviour within team and with suppliers
- Reduced risk

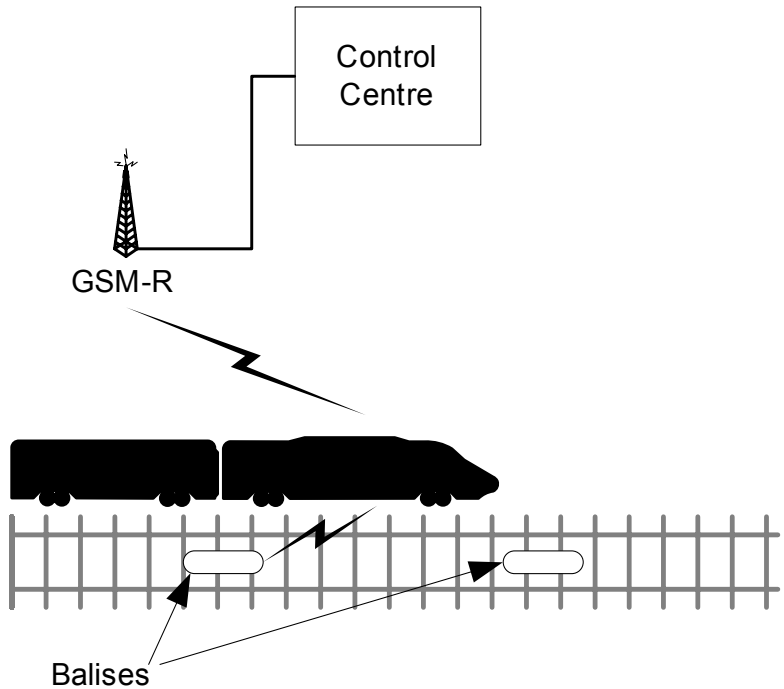
Case Study 2 (1) – Interoperability

- Interoperability has many requirements:
  - ➔Functions
  - ➔Interfaces
  - ➔Operating procedures
  - ➔Maintainability
- Use of defined interfaces is key
- Standard interfaces encourage use of standard components



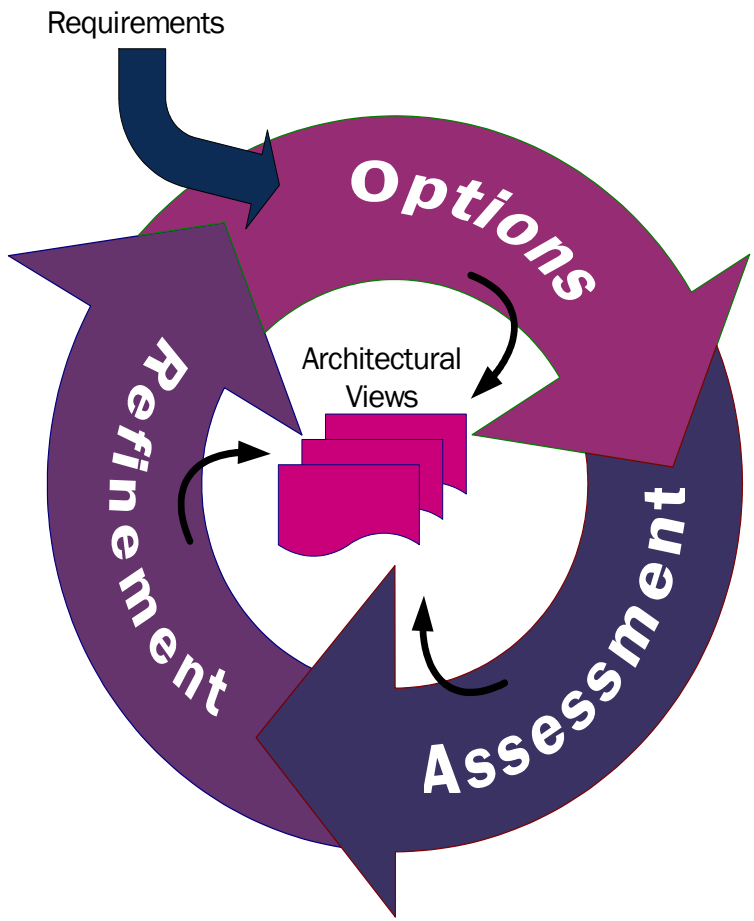
Case Study 2 (2) – Interoperability Issues in ERTMS

- Physical and mechanical:
  - ➔equipment in train:
    - MMI, balise reader, speed sensor outputs,
- Electronic:
  - ➔Balises to train
  - ➔Programming balises
- Human
  - ➔driver / MMI
  - ➔controller / system
  - ➔maintainer / equipment

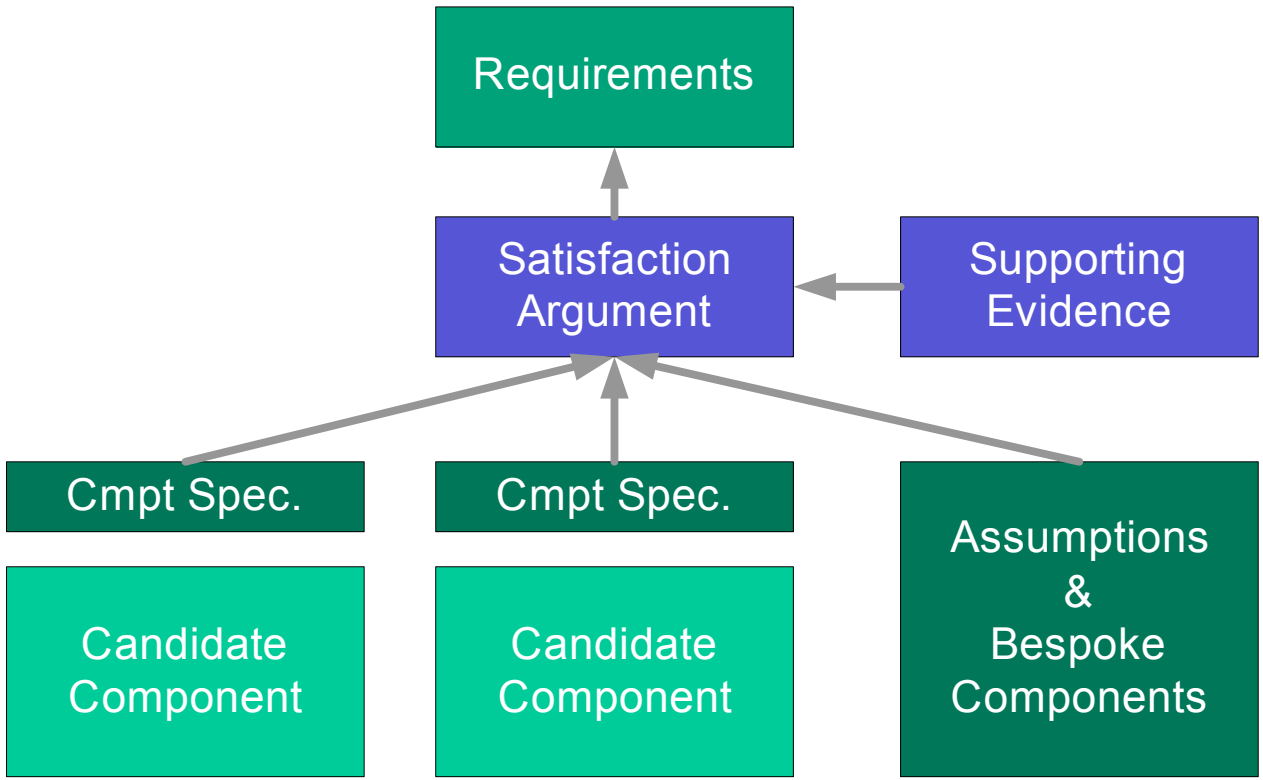


Case Study 2 (3) – Approach

- Operational concept at system level
- Standard products implement interfaces
- Iterative development of
  - ➔Local adaptations to products
  - ➔Configuration specifications
  - ➔Bespoke elements



Case Study 2 (4) – Information Management

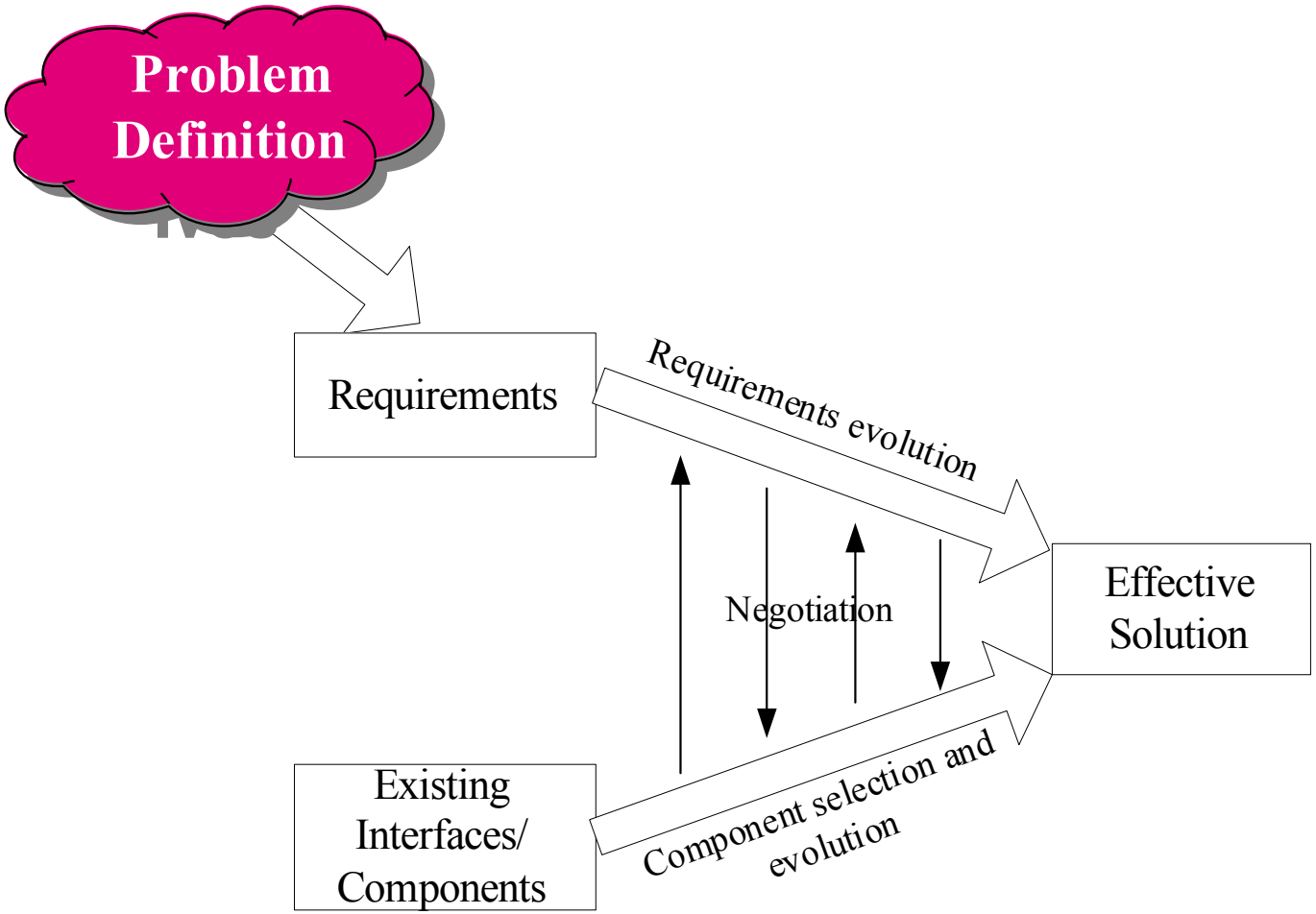


Lessons learnt

- Effective use of existing components requires:
  - ➔Clear vision of requirements and specifications
  - ➔Flexibility to negotiate solutions and requirements
  - ➔Mechanisms for effective communication
  - ➔Controlled product lifecycles
  - ➔Proactive risk management

- Management of interoperability requires well-defined:
  - ➔Subsystems – scope, behaviour, performance etc
  - ➔Interfaces – physical, electronic, power supplies, EMC
  - ➔Controlled and synchronised maintenance and upgrade strategy

A suggested approach…



Closing recommendations…

- Manage gap between products and requirements
- Analyse the 'sum' of the products to ensure system requirements are met
- Ensure necessary product support is available during system life
- Ensure clear distinction between requirements and a product's specification

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