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4 Box Development Model

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SAAB – Current Aerospace Development Projects

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Agenda

- Background
  - Challenges with complex systems engineering
- Why are traditional models not sufficient?
- Solutions by Saab Aeronautics
  - Integration anatomies
  - The 4-box model
- Discussion and conclusion

Complex Systems Engineering

- **Increased complexity** in systems and systems of system
  - Systems Engineering Methodology **hard time keeping up**
- Difficult to **predict activity durations**, challenges in **integration**
- **Resilient** and **dynamic planning** capability required

Development: Managing the Beast

At least 4 planning views looking into the future:

- **Requirements**
  - The desired properties of the realised system
- **Architecture**
  - The desired structure, behaviour, interfaces of the realised system
- **Resources**
  - Who shall perform the work, and when
  - Priorities between contesting tasks
- **Time**
  - The desired point in time when a particular realisation should be ready

There is a lot of **uncertainty** embedded in these views

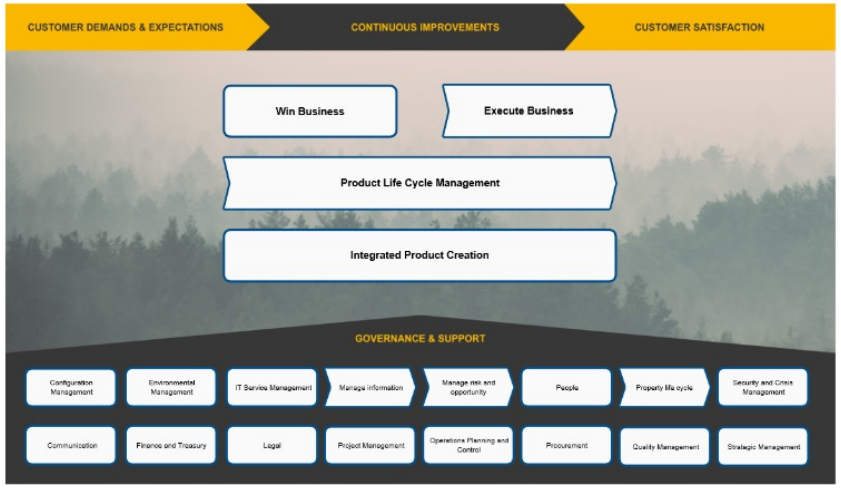
Proper application of modelling and simulation may decrease, but not remove the uncertainty

What we will integrate a long time in advance is hard/impossible to predict

There is also the constant change in the opportunities of when to integrate

Development Models

- Waterfall
- Vee
- Spiral
- Dual Vee
- Wedge
- Agile approaches



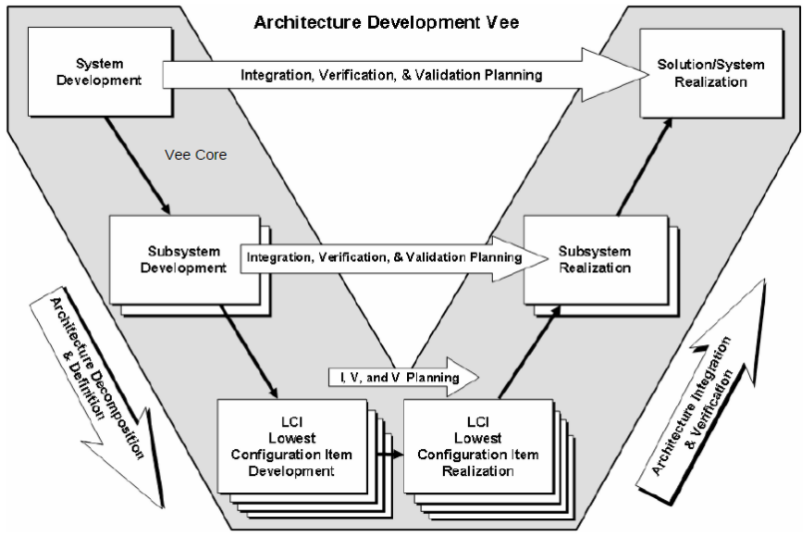
”All models are approximations. Essentially, all models are wrong but some are useful”

George Box

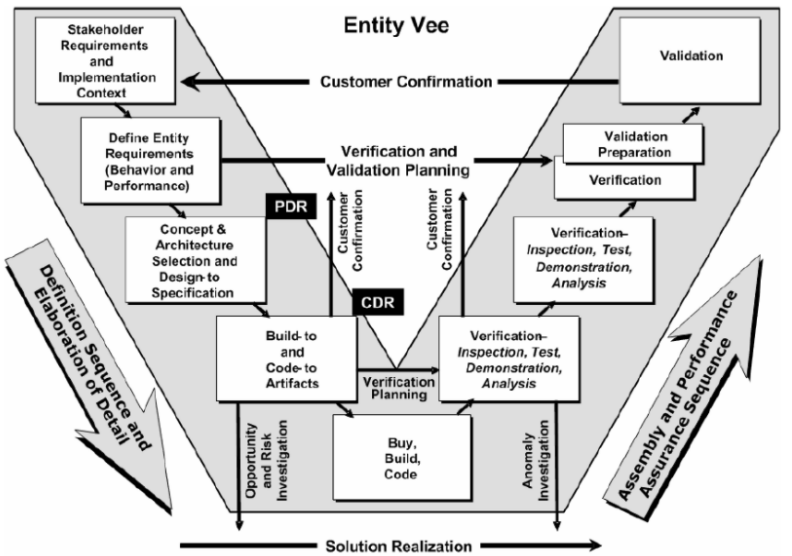
The Vee Model as Baseline

- Essentially 2 Vees

Architecture Vee

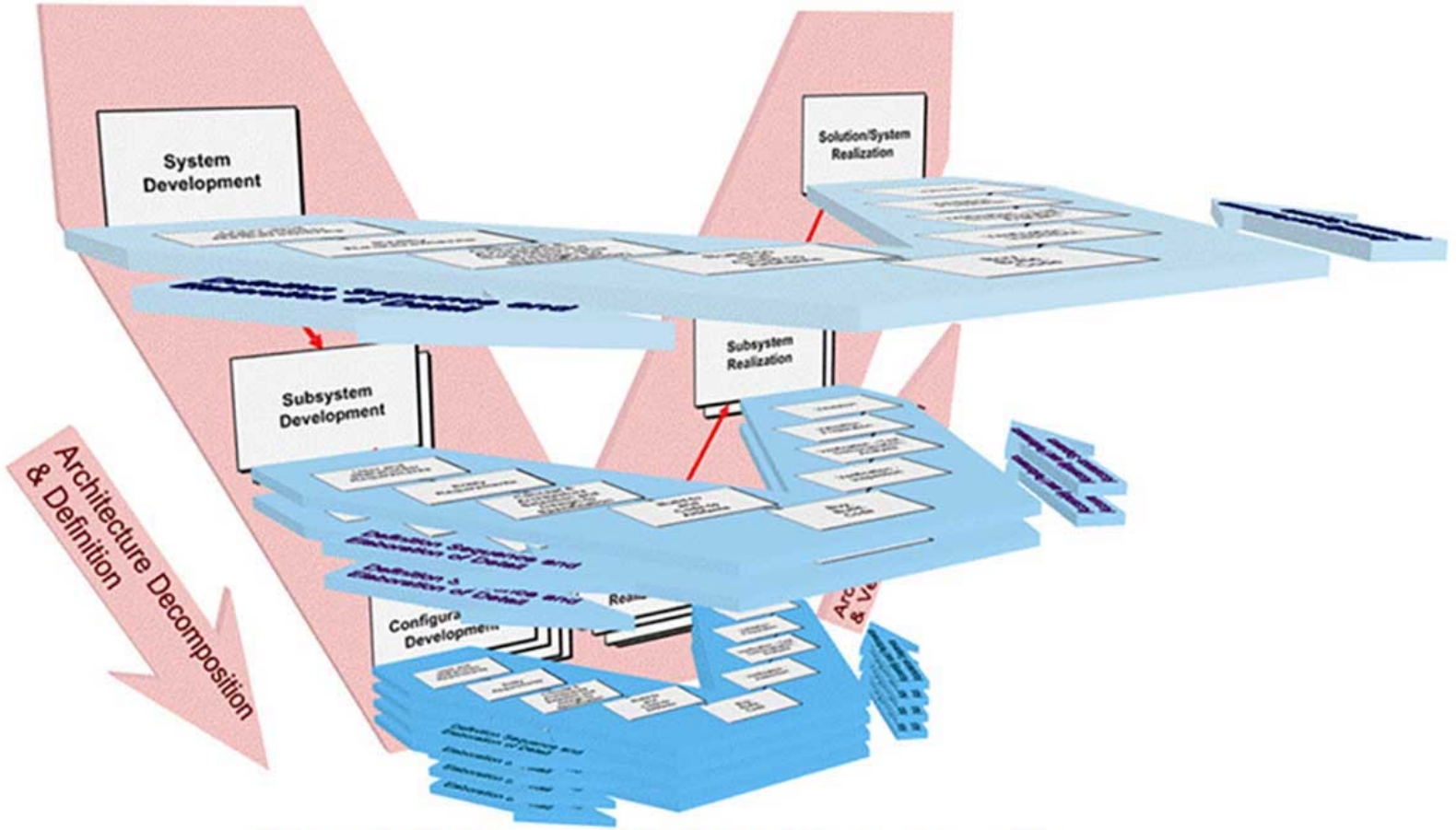


Entity Vee



Figures are copied from (Mooz, H. and Forsberg, K. (2006))

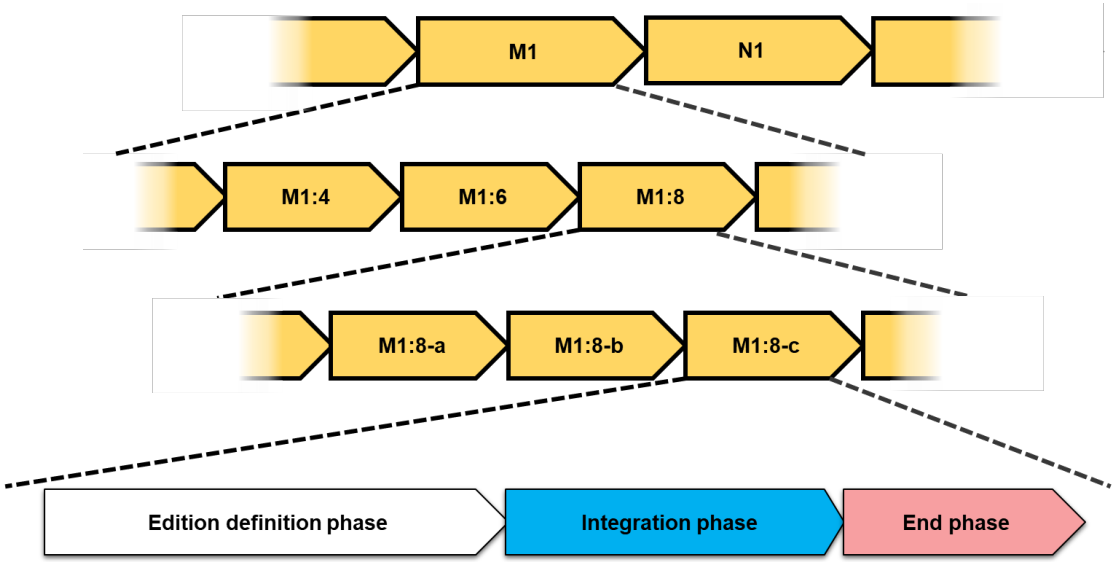
The Dual Vee model



Source: Forsberg and Mooz (2006). Used with permission of the authors under the Creative Commons Attribution 3.0 License..

Incremental Development

- Incremental development
- Block level
- Continuous development



Vee Model's Shortcomings

- Little focus on early phases
- Little guidance on when to start activities
- Vee model appears to imply that work started together is integrated together
- Doesn't work well for complex systems integration

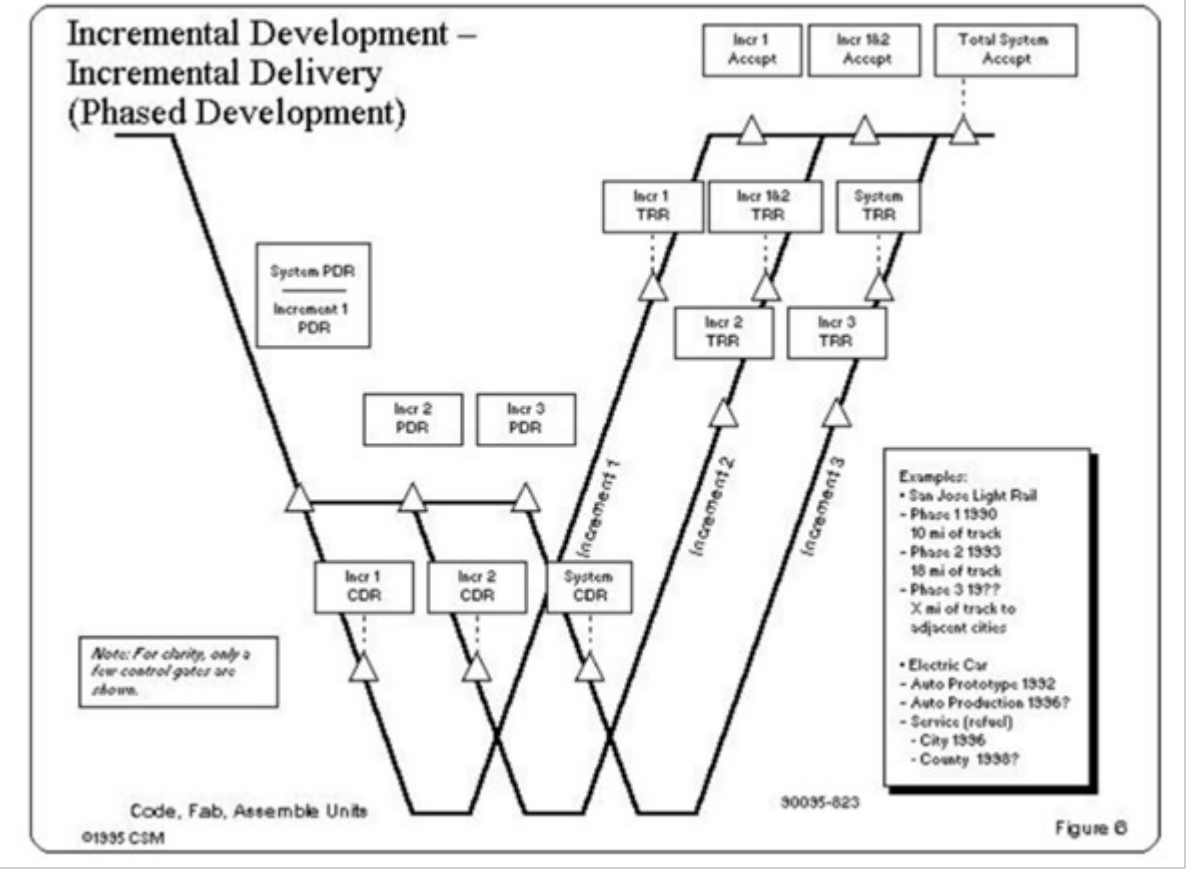
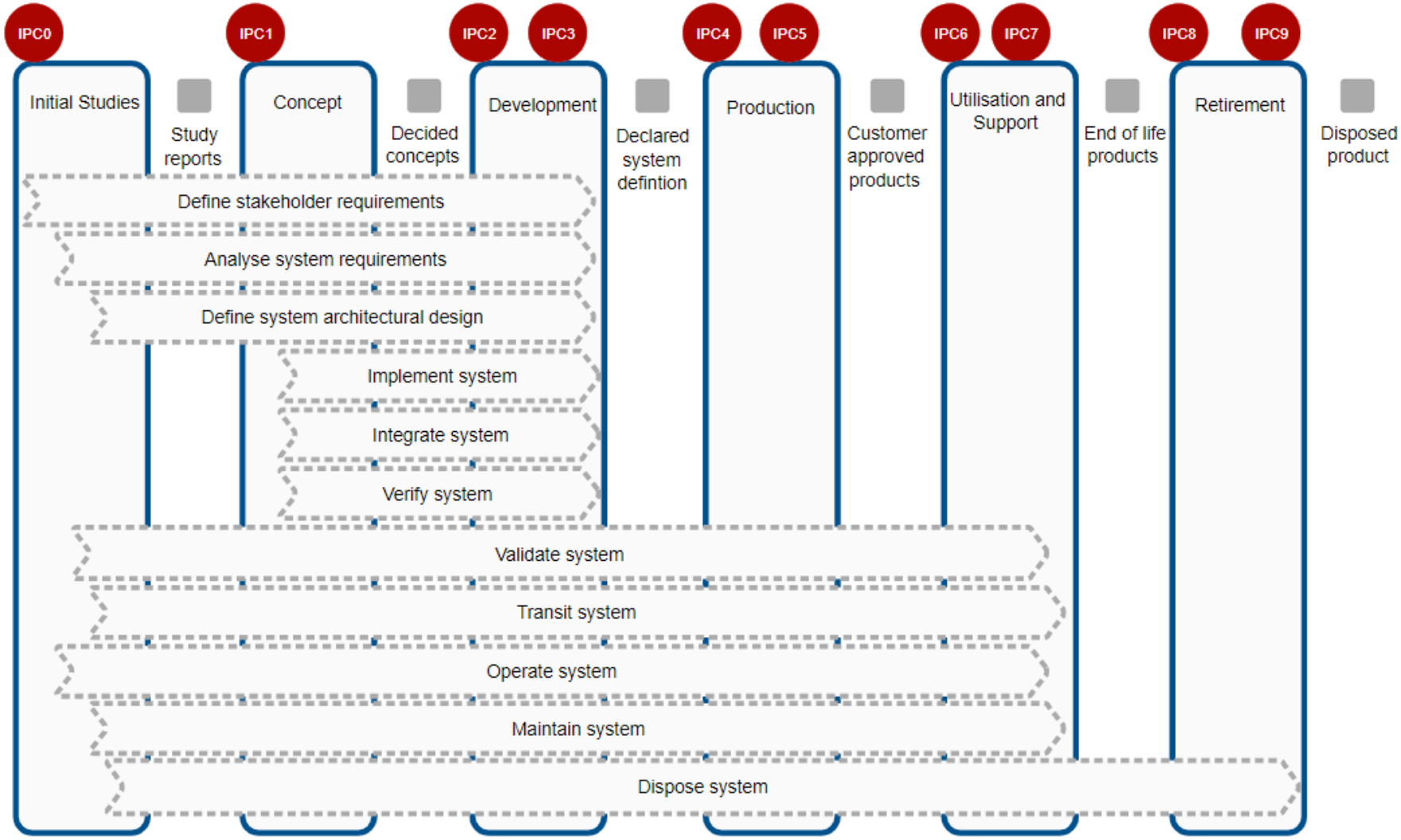


Figure is copied from (Forsberg, K. and Mooz, H. (1991))

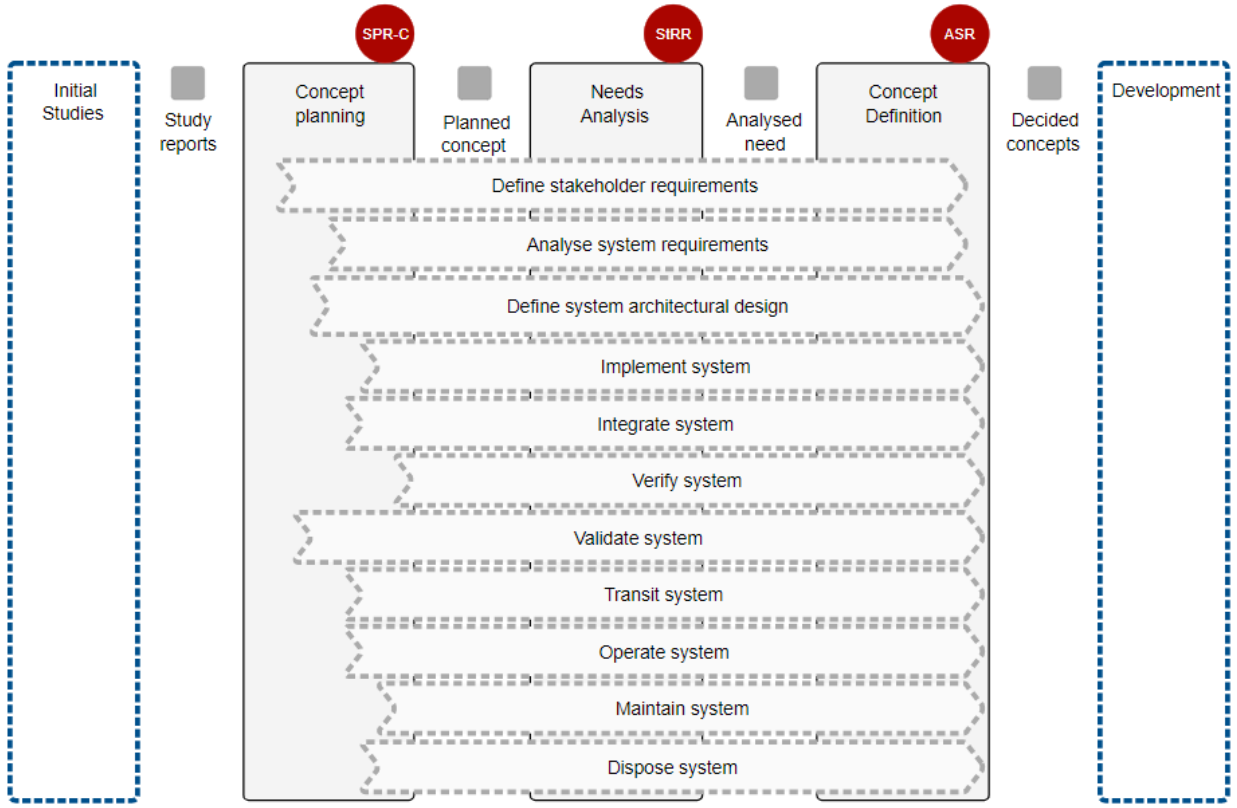
Saab approaches for addressing identified problems

Process over the lifecycle



Focus on the Early Phases

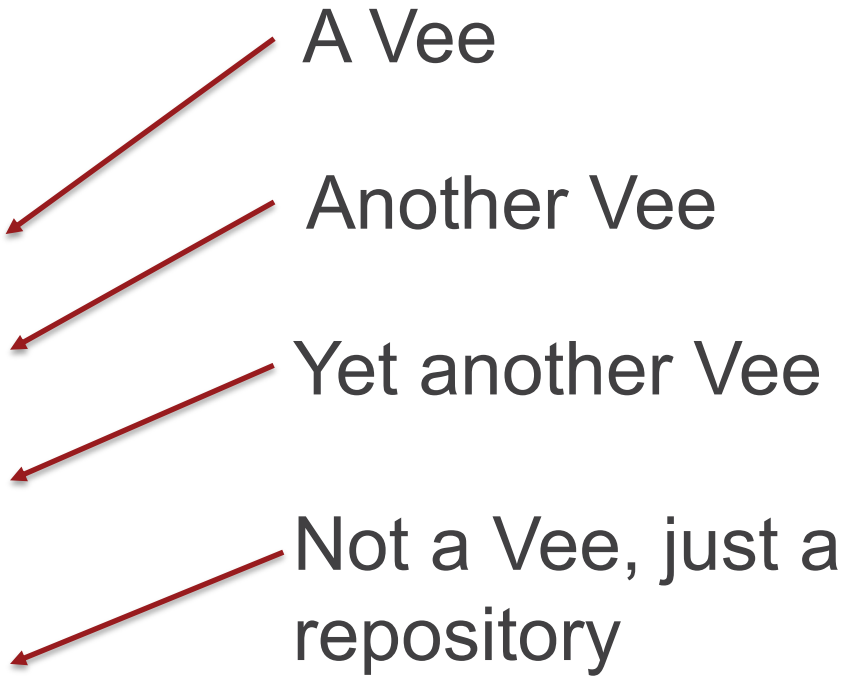
- Formalized early phases
  - Dedicated Concept phase
- Additional reviews – compared to IEEE 15288.2
  - StRR – Stakeholder Requirement Review
  - SPR – System Planning Review



Needs

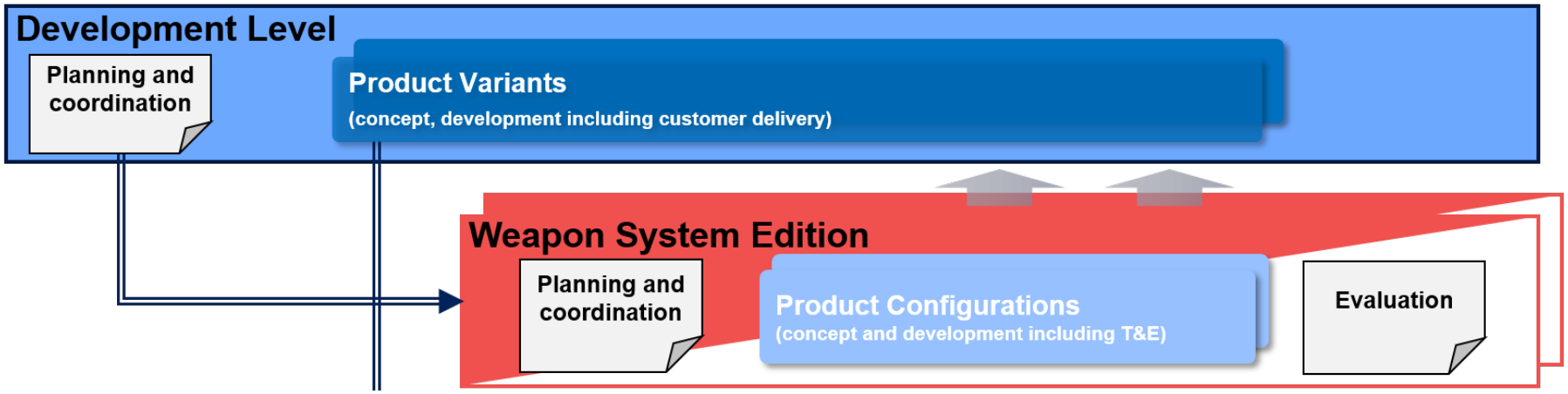
A model usable for development planning, i.e., capturing:

- The long-term interaction with end-user stakeholders
- A structured and resilient approach to incremental integration
- Development activities to incrementally increase system capability
- Support for Product Line Engineering
  - The ability to quickly configure specific variant configurations from a set features

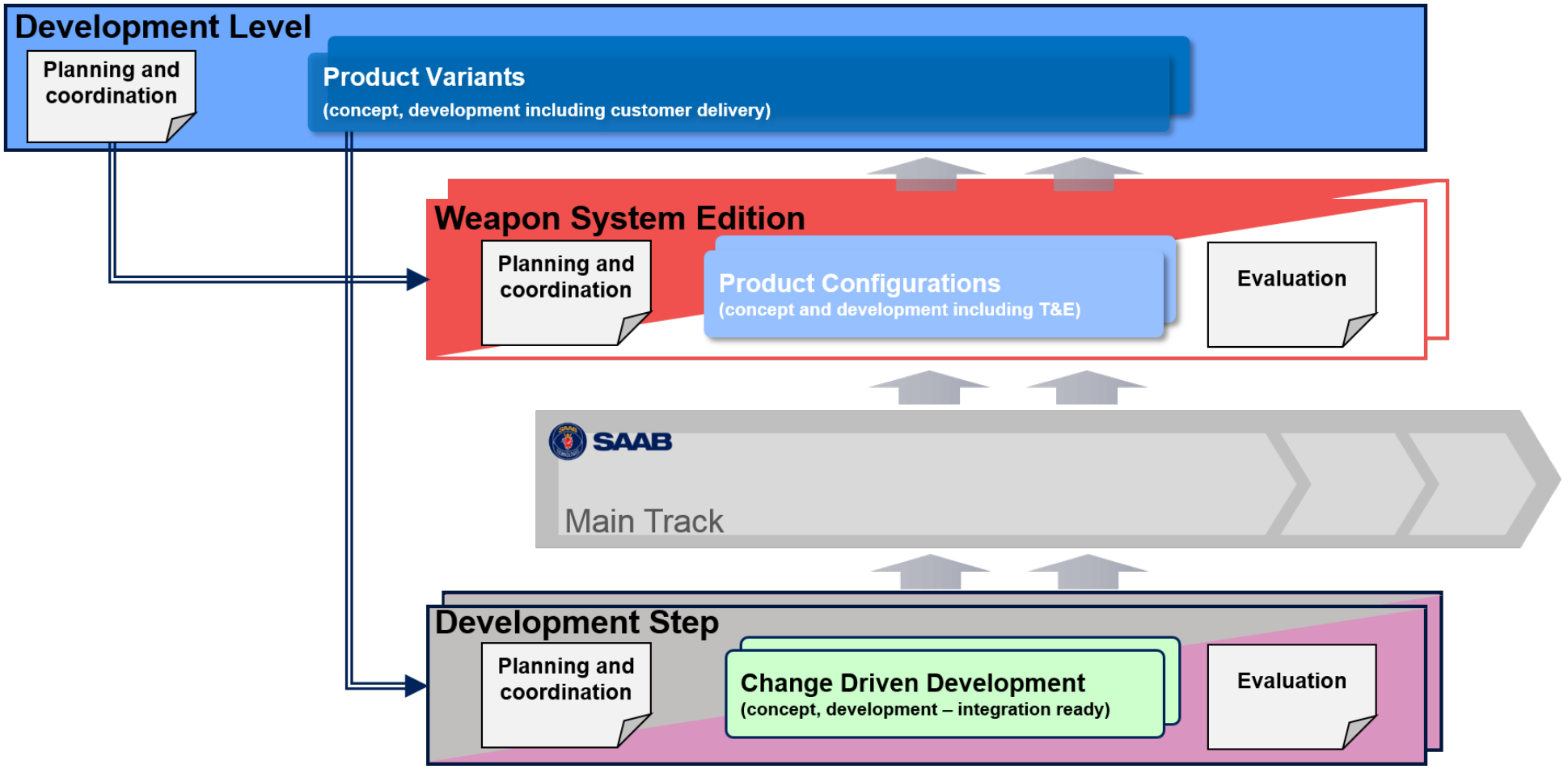


External long time view

Stepwise realisation



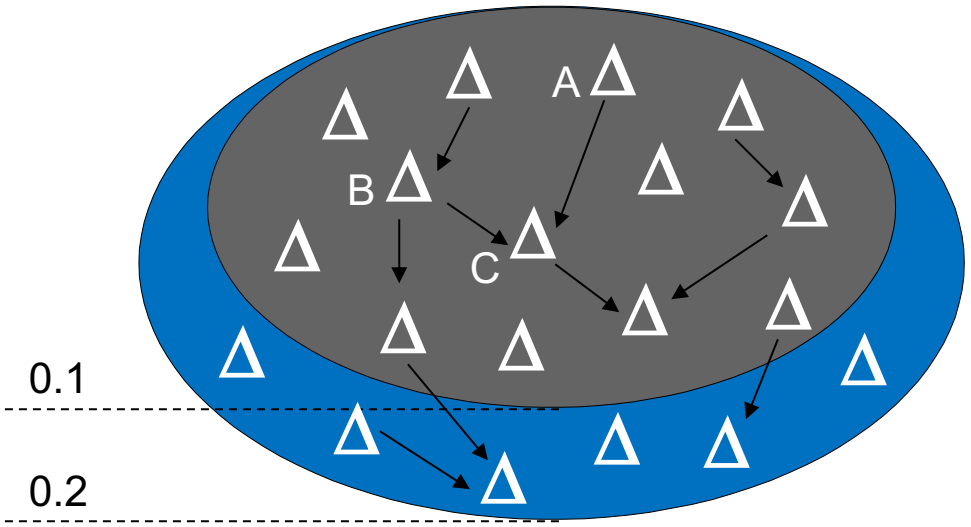
With multiple, parallel development activities



Managing integration under uncertainty

Managing Integration Using Anatomies

Accept that individual activities are not predictable – keep alternative integration paths open as long as possible



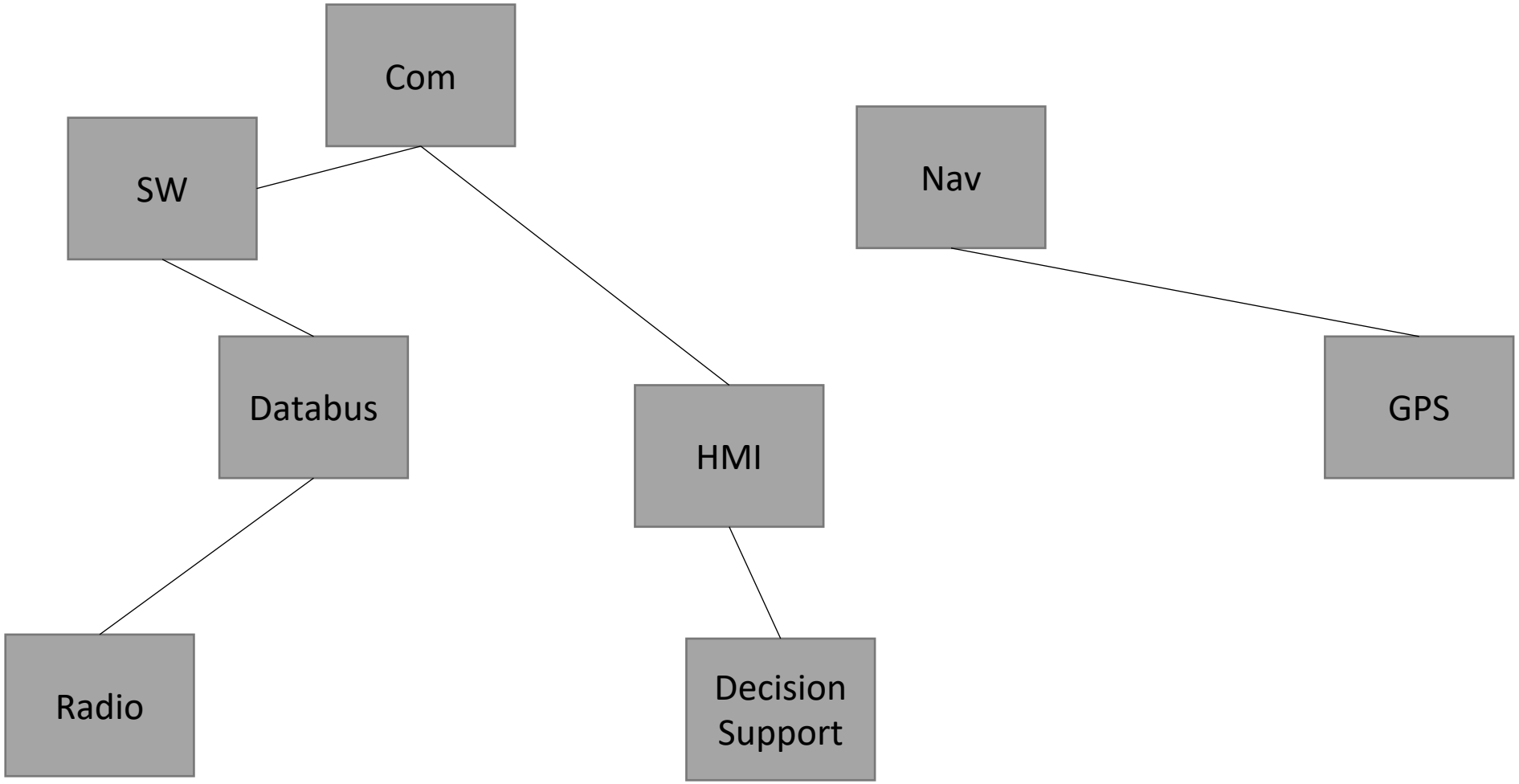
Δ Anatomy

The anatomy shows all currently planned system changes (Δ) and their dependencies.

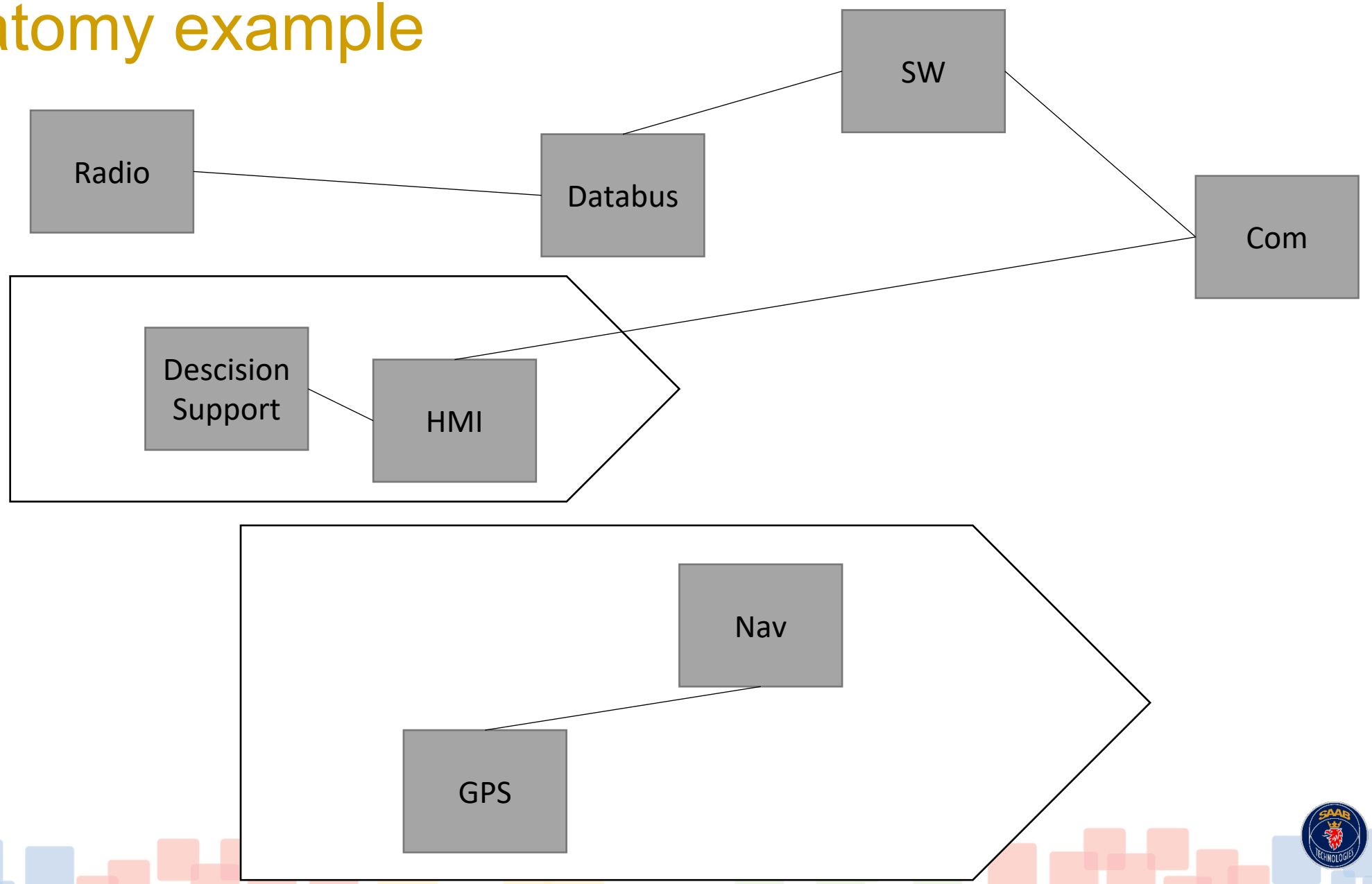
The dependencies constrain the order in which changes can be finalised and determine the possible level of parallelism.

→ Integration Dependency: Both A and B must be integrated before C can be integrated and tested.

Anatomy example

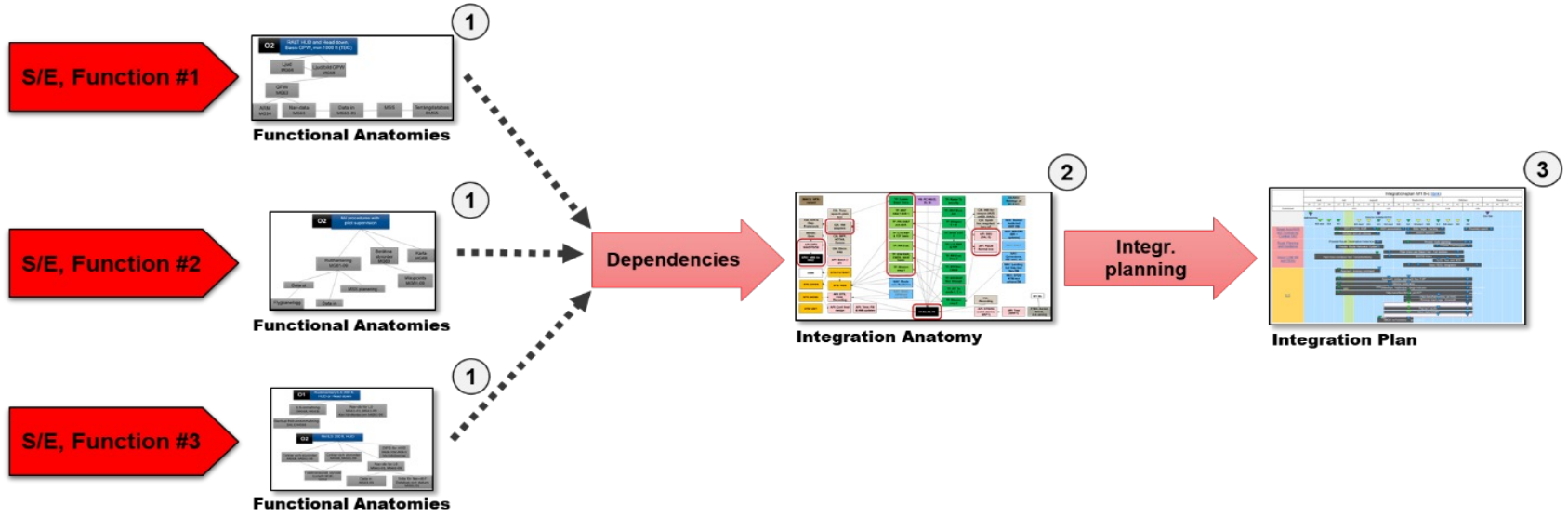


Anatomy example

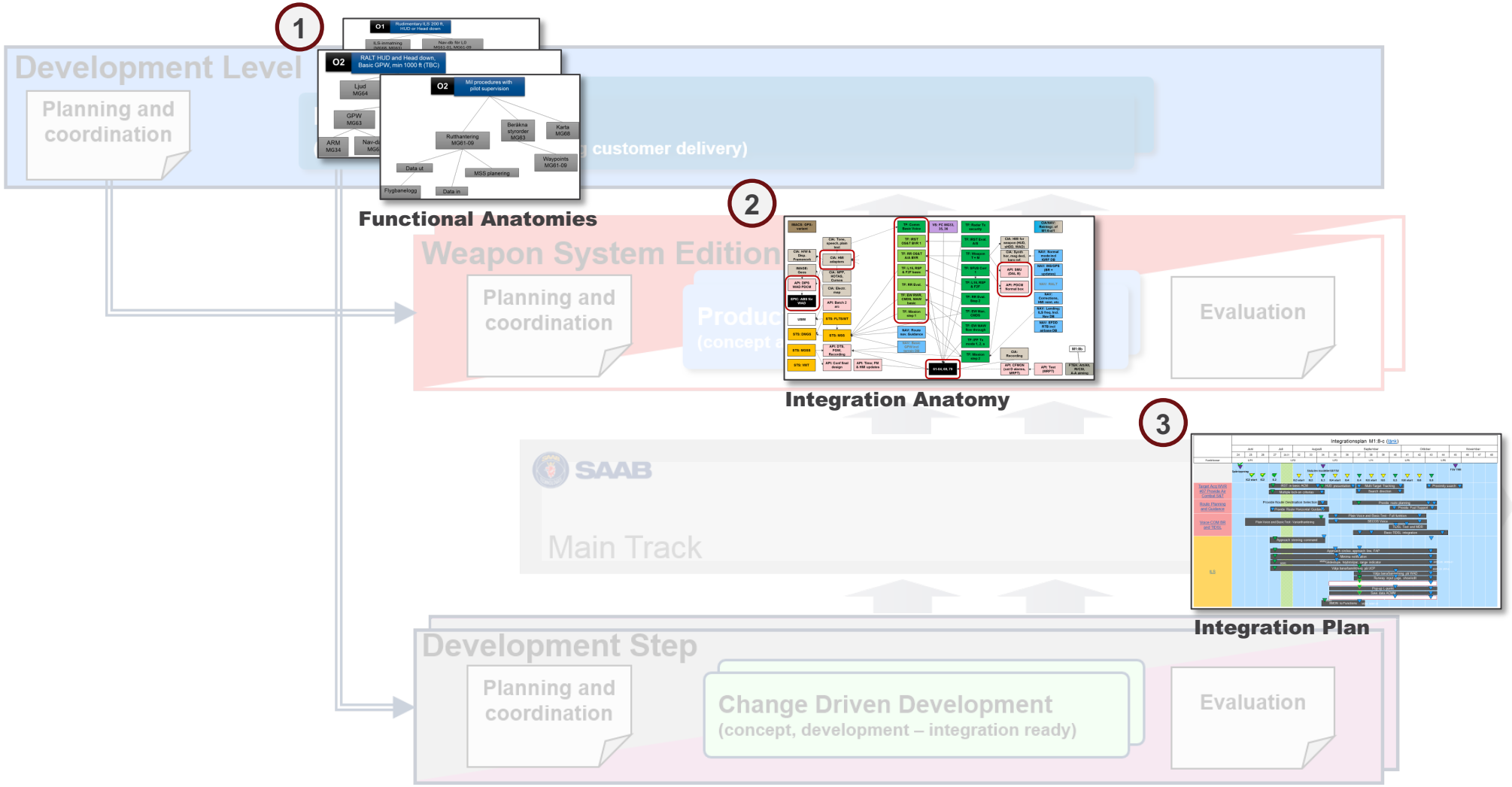


Integration Anatomies

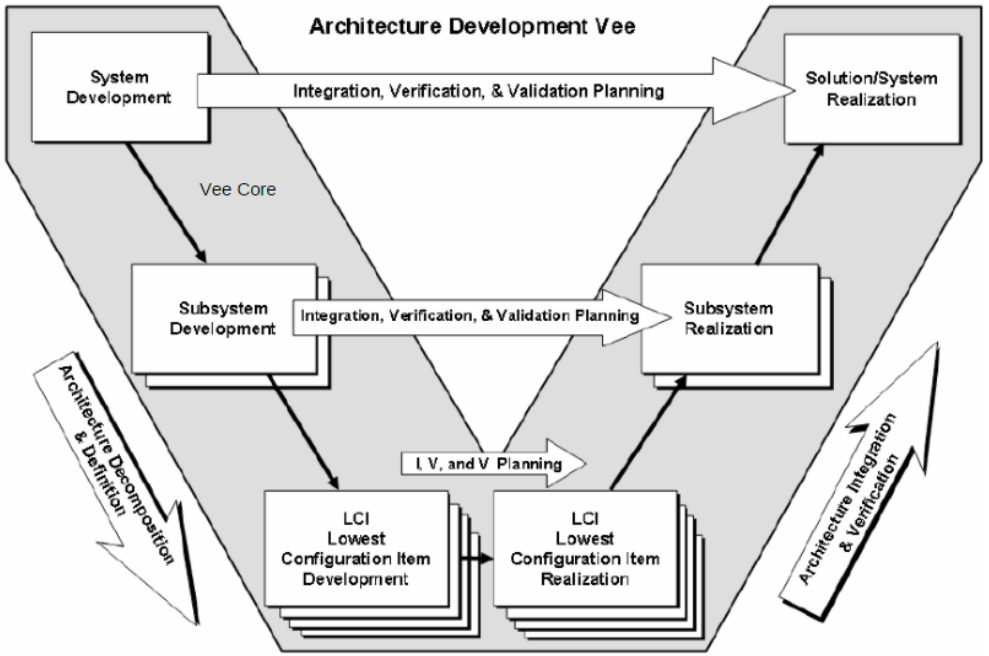
- Anatomies are produced in three stages
  - Functional anatomies – the order for realisation
  - Integration anatomies – the potential integration order
  - Integration plan – the current time plan

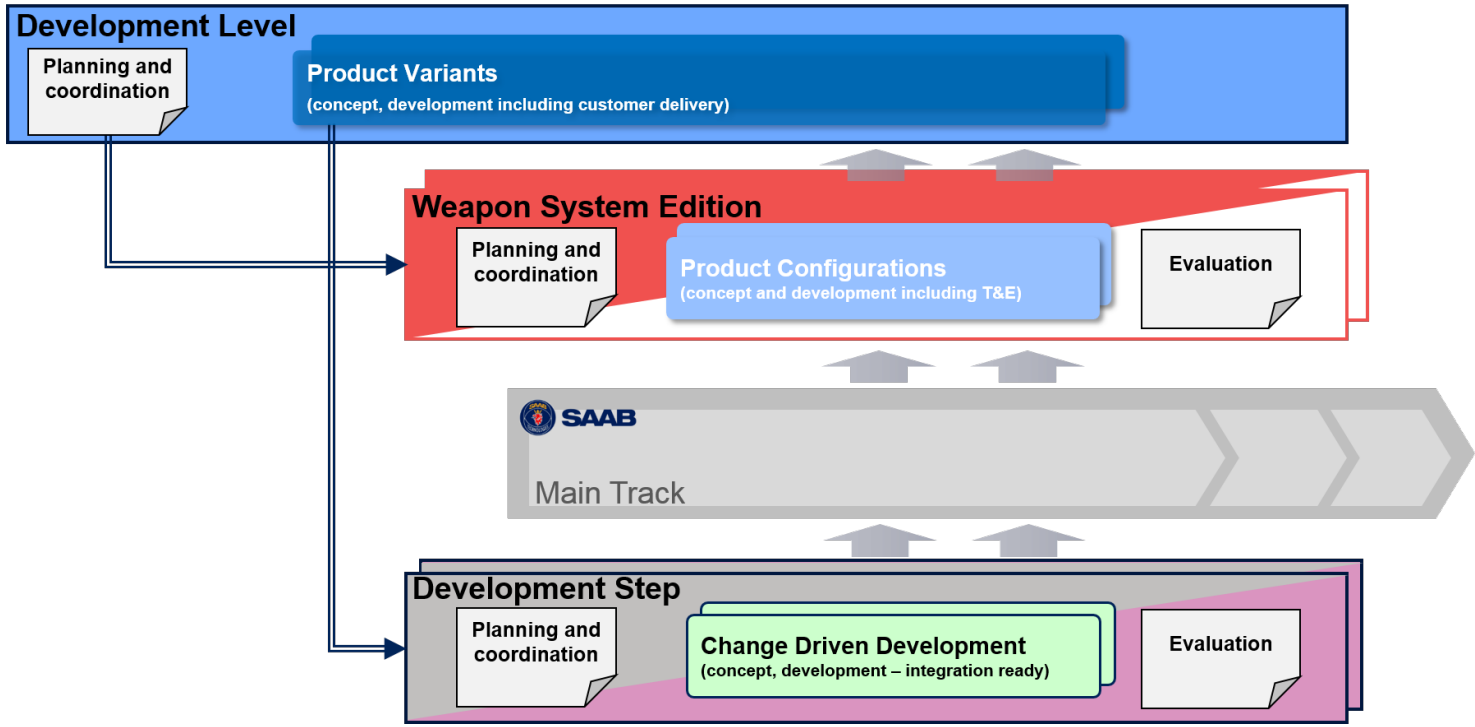


Merge 4-Box Model and Integration Anatomies



Discussion


Architecture Development Vee
System Development
Integration, Verification, & Validation Planning
Solution/System Realization
Vee Core
Subsystem Development
Integration, Verification, & Validation Planning
Subsystem Realization
I, V, and V Planning
Architecture Decomposition & Definition
LCI Lowest Configuration Item Development
LCI Lowest Configuration Item Realization
Architecture Integration & Verification


Development Level
Planning and coordination
Product Variants
(concept, development including customer delivery)
Weapon System Edition
Planning and coordination
Product Configurations
(concept and development including T&E)
Evaluation
SAAB
Main Track
Development Step
Planning and coordination
Change Driven Development
(concept, development – integration ready)
Evaluation

Summary

- Presentation of Vee model shortcomings – from a Saab perspective
- Introduction of a 4-box development model to
  - Separate development activities with different time horizons
  - Support agile development
  - Manage multiple integration configurations
  - Support a product family approach
- Integration anatomies to manage integration alternatives
- Discussion pros and cons

The presented model is right for Saab – but we have to remember:

”All models are approximations. Essentially, all models are wrong but some are useful”

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