# Service Oriented Architecture for Agricultural Vehicles

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Automotive Software Engineering
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THE END – of Embedded Software?

www.electronics-ktn.com/

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Structure

Statement

Status and challenges for Embedded Software in Ag Engineering

Definition of service

Possible solutions
- Infrastructure
- Variant management
- Modular design of software

Summary

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Reasoning for Embedded Software

- **Limited features / requirements**

- **Availability of ruggedized hardware**

- **Performance**

- **Limited Memory**

- **Software Development Tools**

- **Cost**

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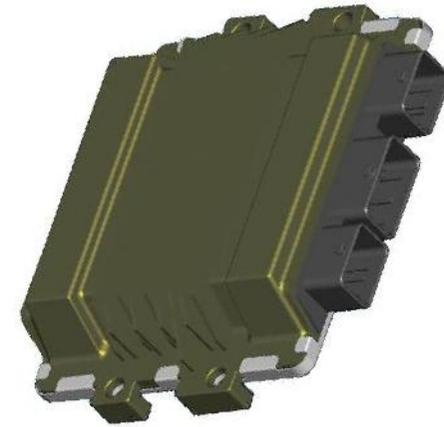
Challenges for Software Developing Organizations

- Need for reducing cost, effort and time-to-market

- Complexity and software size increases

- Increasing request for

  - Quality software and
  - Individually customized products
  - Real time data transfer with high bandwidth

- Growing number of product variations

- Projects with more and more (outside) Partners
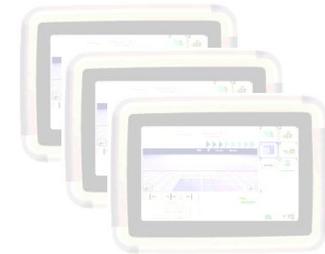
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Structure of grown software systems

Dependencies – Visualization of the Structure
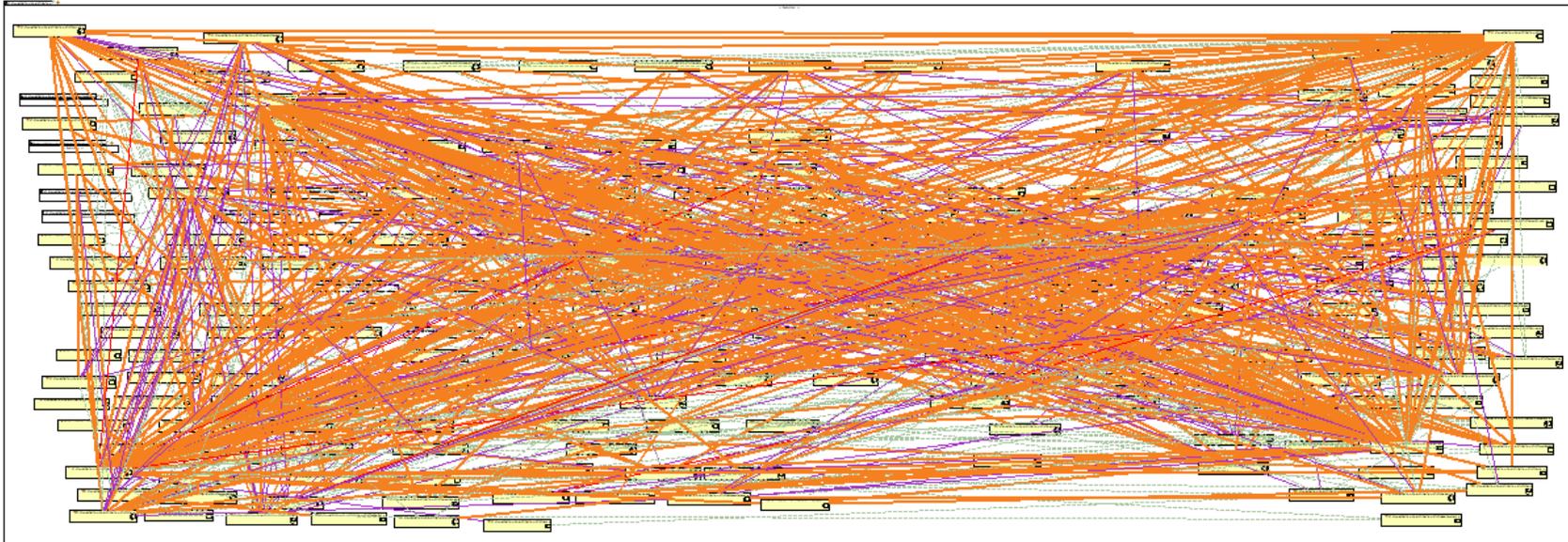
No subsystems, no predefined structure

7828 relations between 208 files (4355 relations between 121 entities*)

Study from John Deere with Fraunhofer IESE March, 2009

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Compatibility of different branded systems

- No manufacturer has the complete fleet of equipment needed by a typical farmer

- Customers expect Plug & Play functionality between manufacturers

  - Standardized connectors (mechanical, hydraulic, electronic)

  - Common User Interface

  - Intensive data exchange between mobile equipment and office computers

- Dealers to service 'Rainbow Systems'

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Interconnectivity between brands

Multi-Wire Systems

Dedicated Displays per Implement or Function

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Interconnectivity between brands

Standardized Communication System

Multi-purpose User Interface

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Definition of Software Service Environment

A **service** is the intangible equivalent of an economic good. [Wikipedia]

|	Internal Service	External Service
Customers	Engineering / R&D Product Verification and Validation Publications Group Sales Organization Business & Accounting	Customer Dealer Support Teams Third Parties / Competition Business Partners
Goals	Structurable Manageable Expandable Sustainable Profitable	Useable Upgradeable Supportable Reliable Profitable

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Practical Problem

Size & Complexity

Time

Quality Measure

100%

95%

75%

50%

?

Need for a new system?

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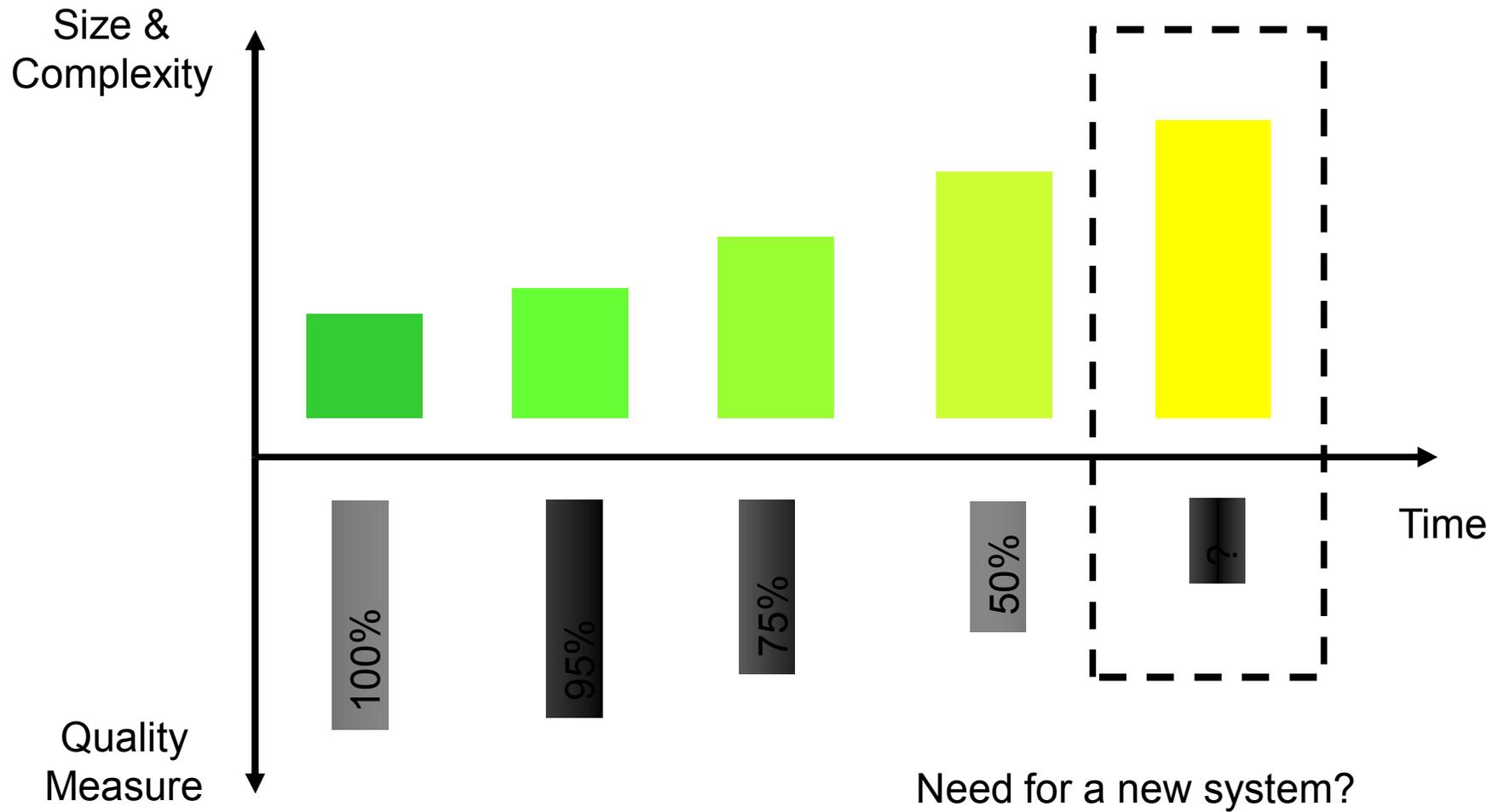
Controlling the Evolution

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Solution Approach

Early avoidance of deviations between architecture and implementation

⬇

Architectural compliance

⬇

Is configuration management included?
Are versions and variants considered?

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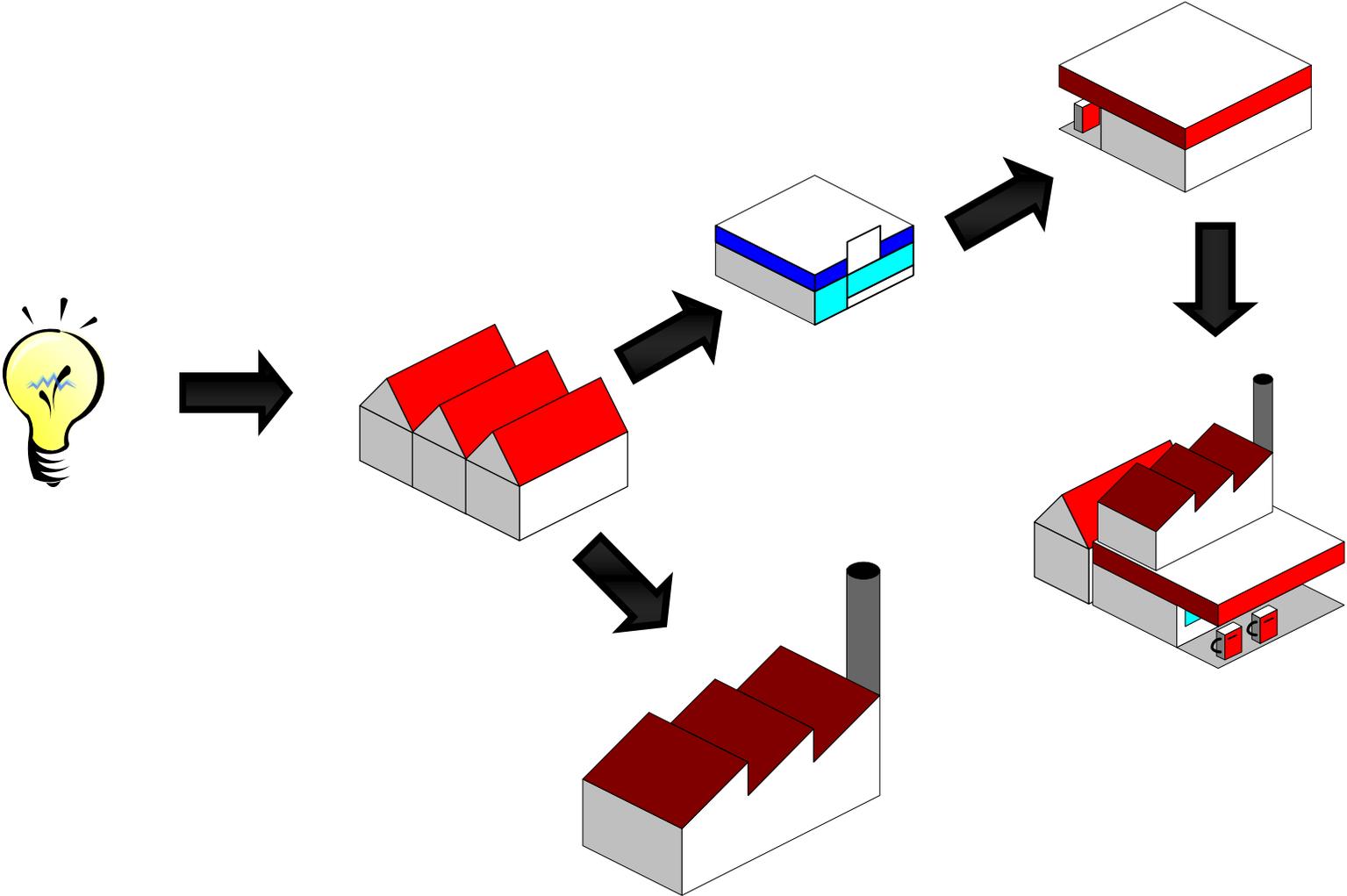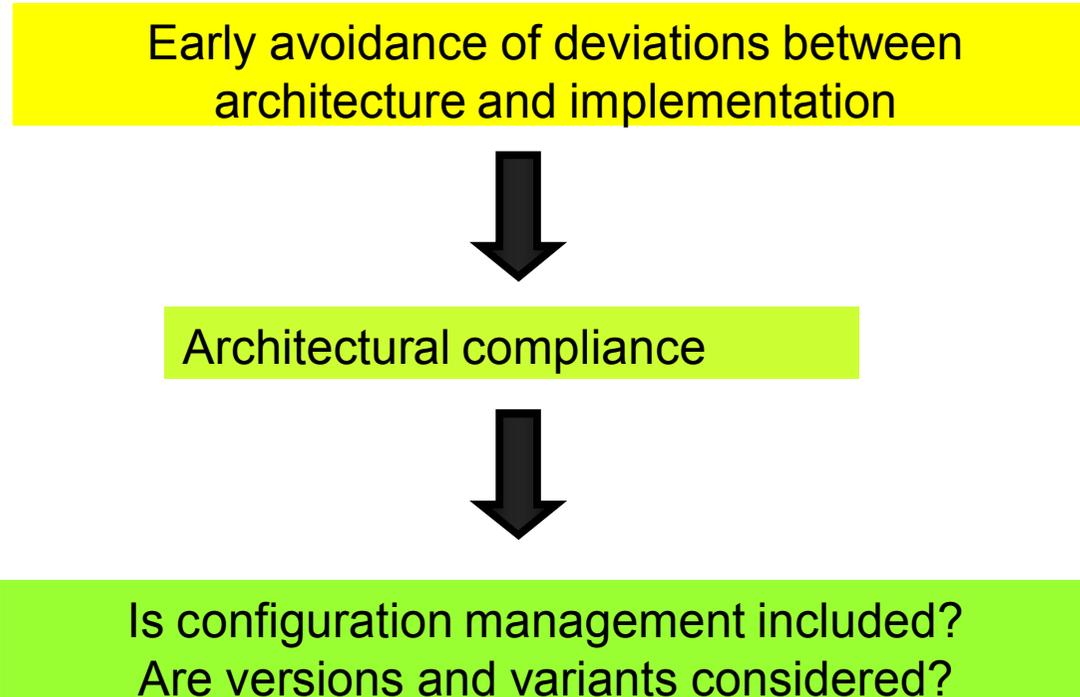
Possible solutions – open architecture

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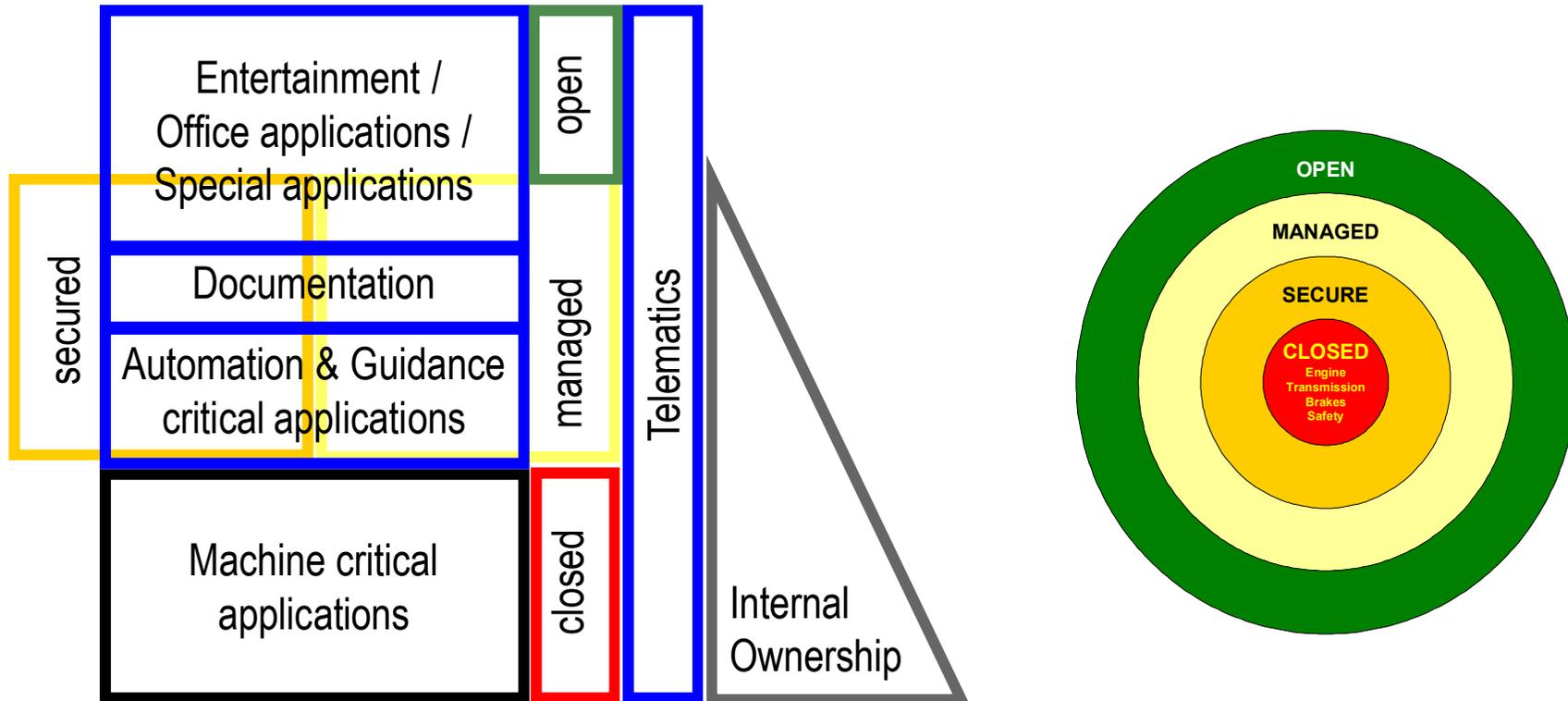
Future architecture concept

CAN Bus (ISOBUS)

"Soft real-time" Network

"Hard real-time" Network

Peripherals USB/VGA

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Clone & Own Principle

VT 1.0.0

VT 2.0.0

VT 2.1.0

VT 3.0.0

VT 2.2.0

VT 4.0.0

VT 2.2.1
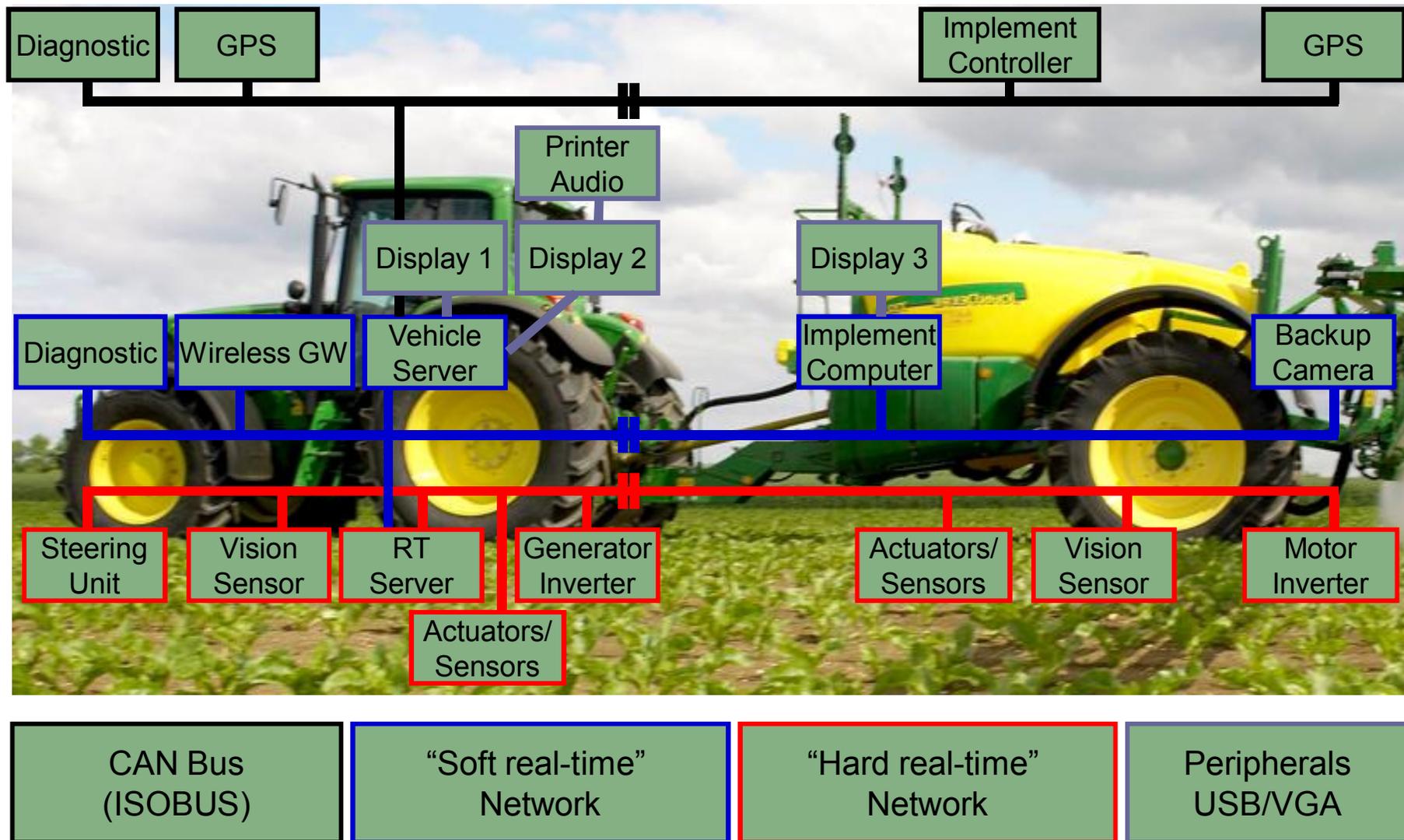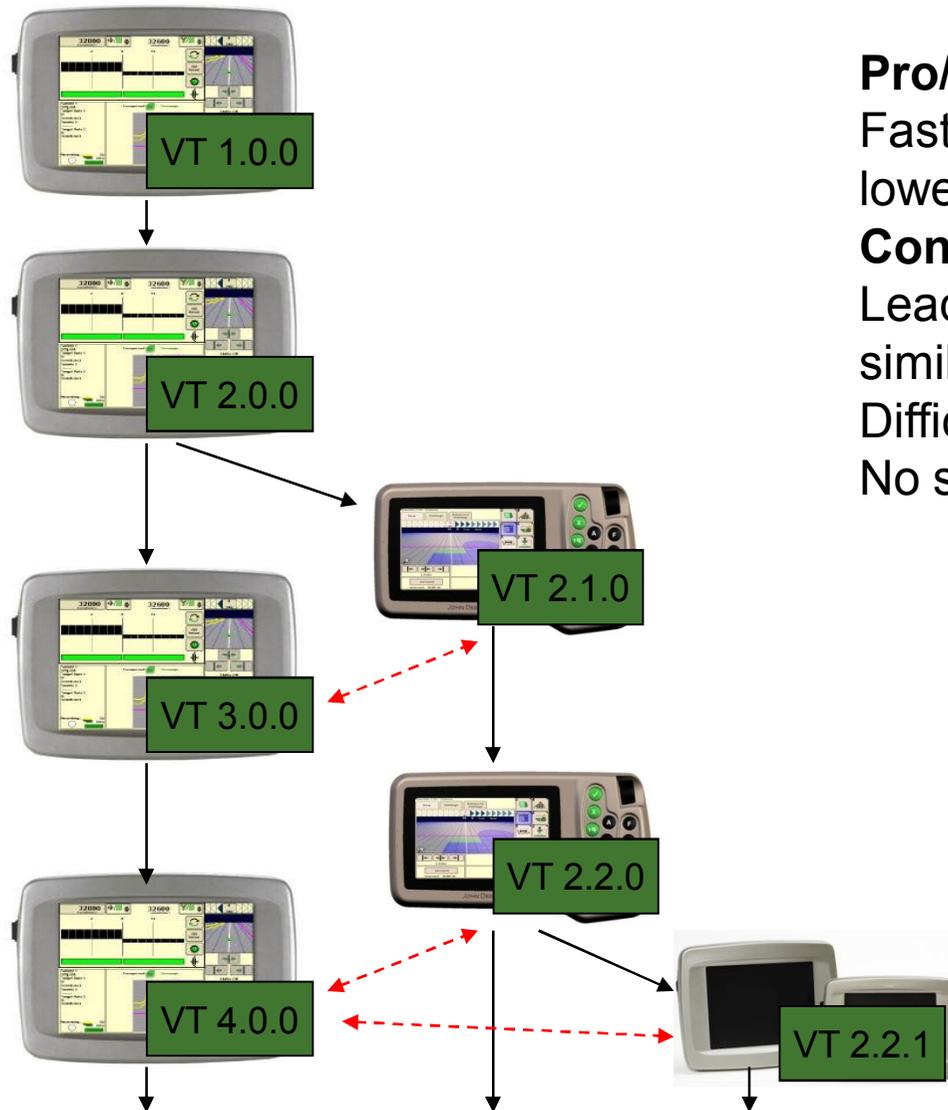
Pro/Reason:
Fastest way to create new variant with lowest risk to existing product
Con:
Leads to many different versions of similar functionality over time & type. Difficult to maintain, evolve, test, etc. No single code base

"Complex interactions between variation in "time" and "space" are the source of complexity of building products in a product family context"

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Components Repository

Prototyp
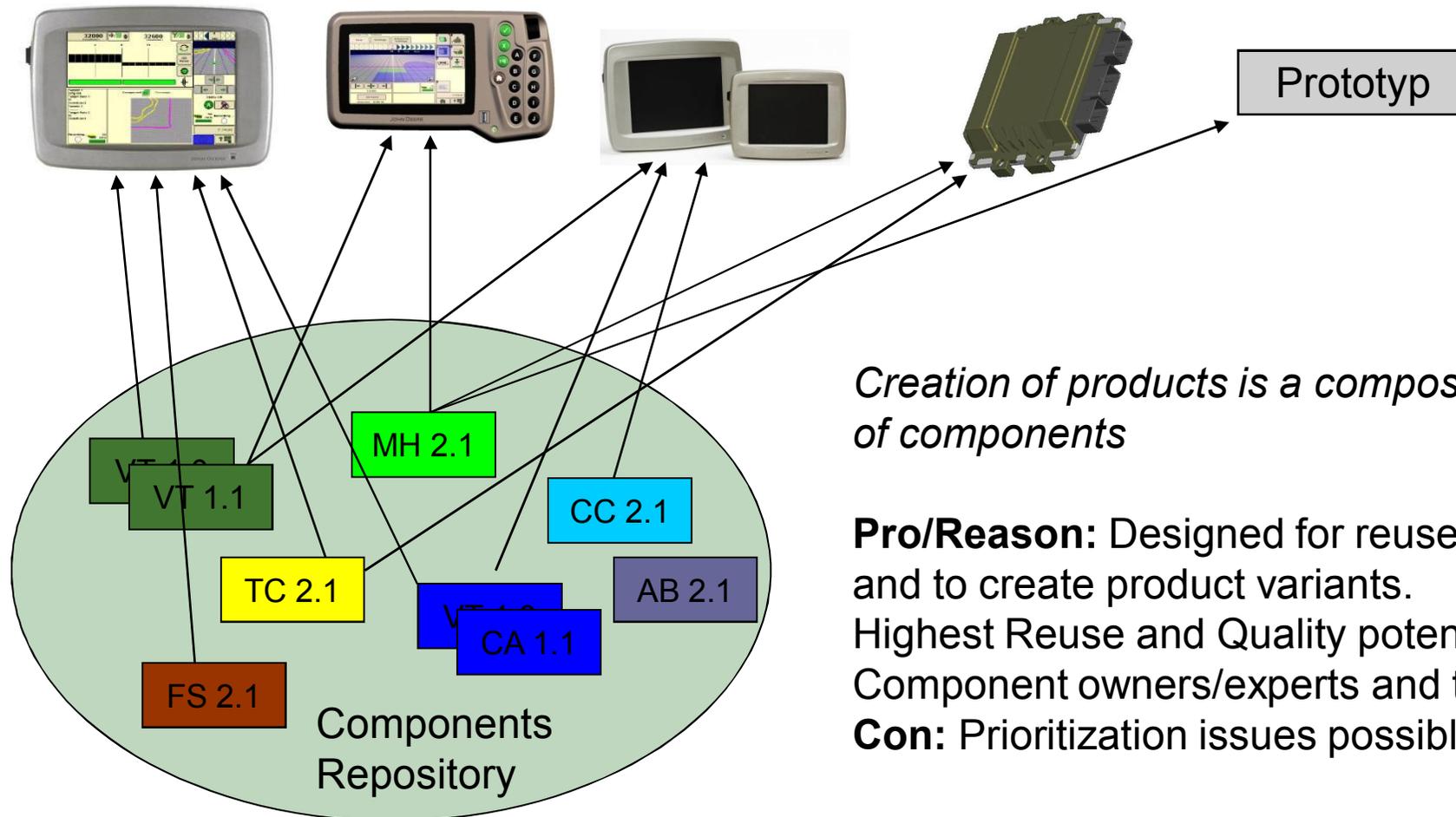
Creation of products is a composition of components

Pro/Reason: Designed for reuse and to create product variants. Highest Reuse and Quality potential. Component owners/experts and test.
Con: Prioritization issues possible

Components Repository

VT 1.1
MH 2.1
CC 2.1
TC 2.1
AB 2.1
CA 1.1
FS 2.1

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Feature-based CM

Decision Modeling

Feature

Feature

Feature

mapping

Component Management

Component

Component

Component

mapping

Configuration Management

Folder

File

File

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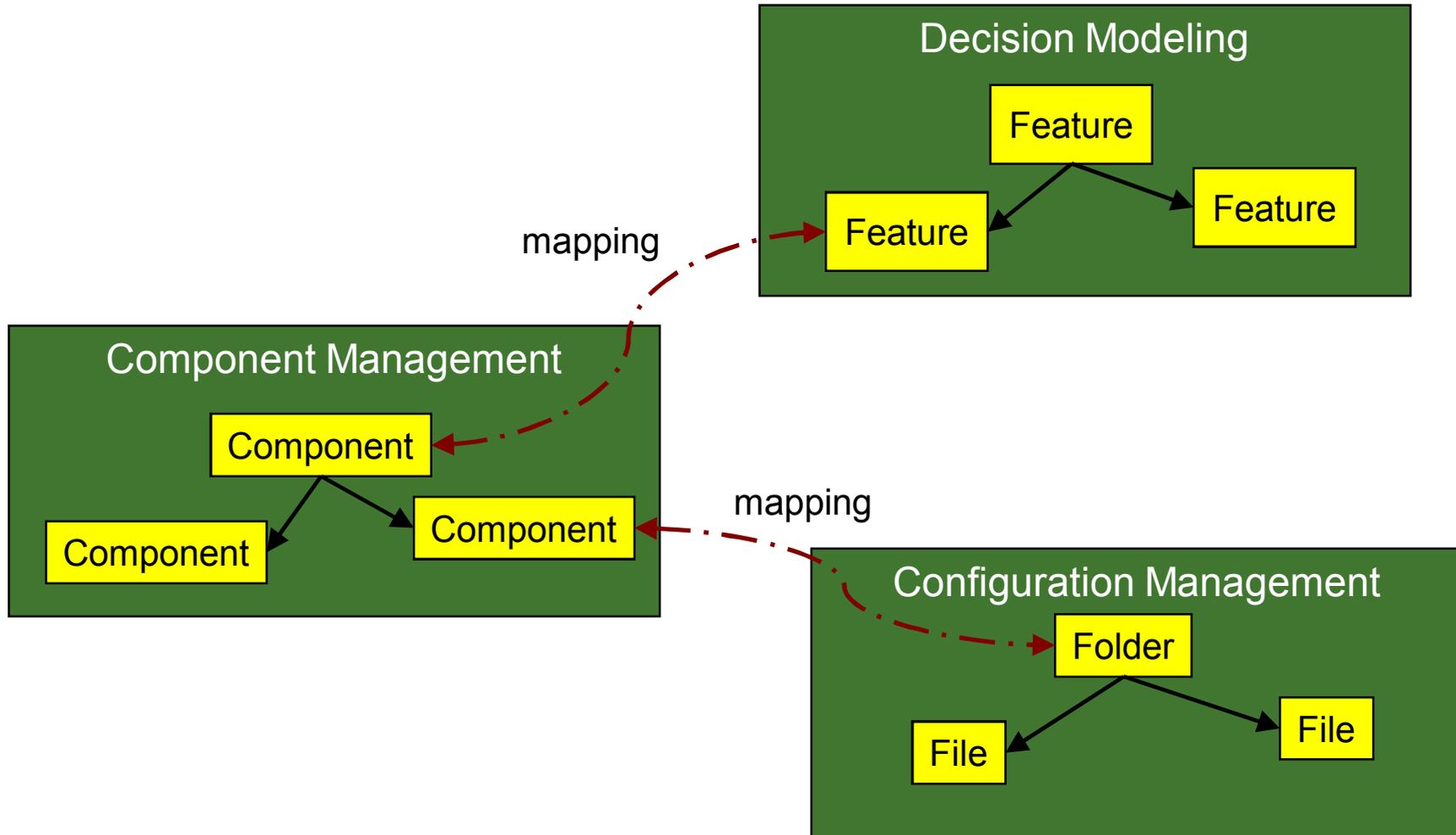
Layered Approach
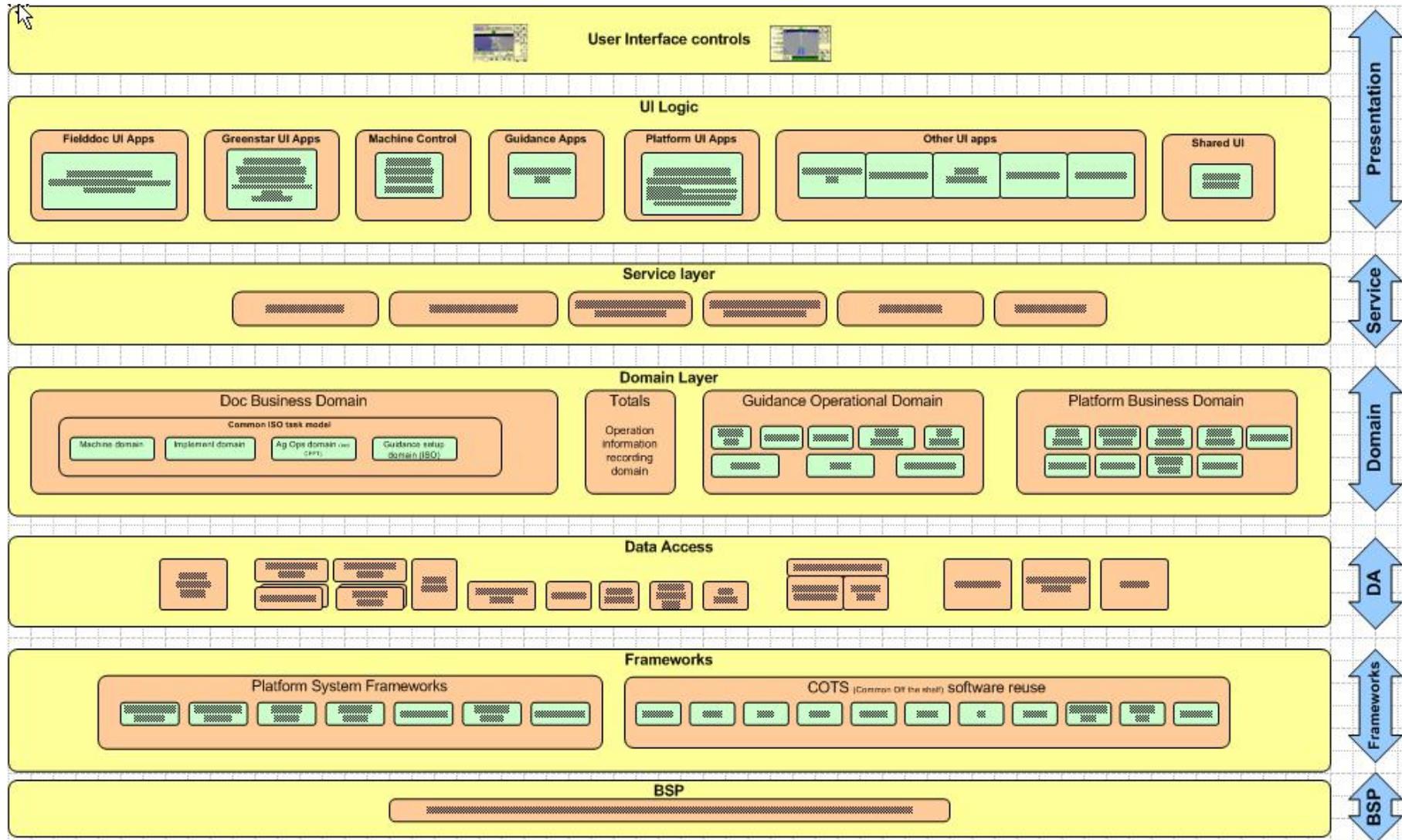
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Model Based Software Development

What is MBSD at John Deere?

- Three distinct but complimentary focus areas in the workflow:

  1. <u>Algorithm Development</u> - use of modeling and simulation techniques to develop algorithms for embedded control applications

  2. <u>Automatic code generation</u> – delivering model based software into the production project

  3. <u>Virtual verification</u> – continuous, simulation-based performance evaluation

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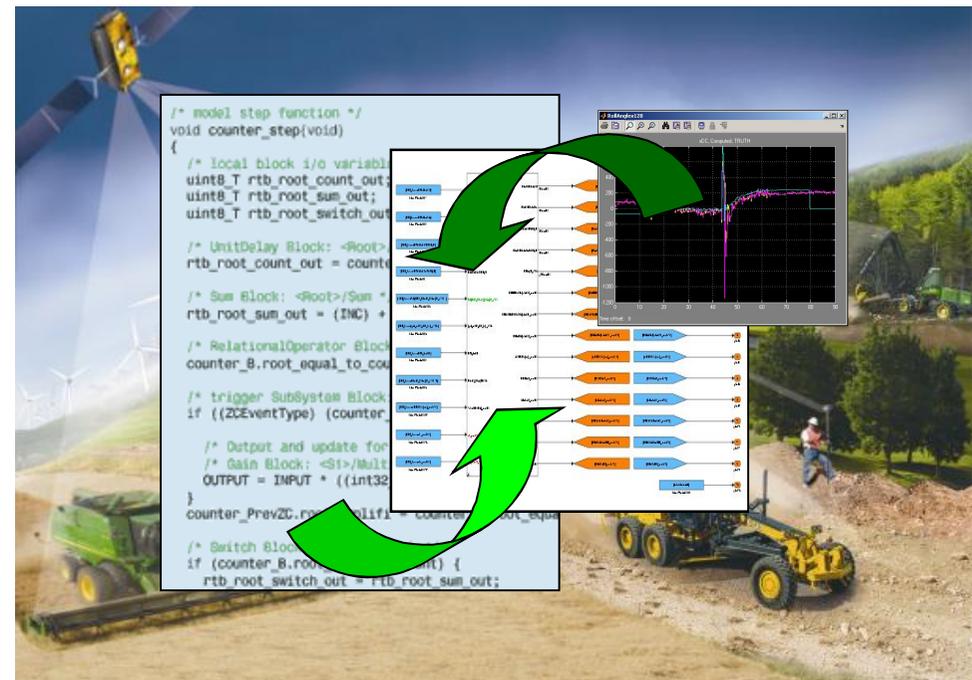
Standardization of Systems / Interfaces

The Agricultural Industry Electronics Foundation is an independent, industry organization which provides the necessary continuing promotion and support for Agricultural Electronics Standards, after they have been developed and adopted by the international community.

The AEF does not actually develop International Agricultural Electronics Standards like ISOBUS.

This function is still handled by ISO TC23/SC19 and the associated Working Groups.

Summary

- **Complex software system will require new architecture approaches and high performance communication infrastructure.**

- **Service oriented architecture will be key.**

- **Open architecture needs to be integrated.**

- **Model based software design supports sustainability.**

- **Embedded software might survive….**

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