SoSECIE Webinar

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2020 System of Systems Engineering Collaborators Information Exchange (SoSECIE)

We will start at 11AM Eastern Time

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NDIA System of Systems SE Committee

- **Mission**
  - To provide a forum where government, industry, and academia can share lessons learned, promote best practices, address issues, and advocate systems engineering for Systems of Systems (SoS)
  - To identify successful strategies for applying systems engineering principles to systems engineering of SoS
- **Operating Practices**
  - Face to face and virtual SoS Committee meetings are held in conjunction with NDIA SE Division meetings that occur in February, April, June, and August

NDIA SE Division SoS Committee Industry Chairs:
Mr. Rick Poel, Boeing
Ms. Jennie Horne, Raytheon
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Dr. Judith Dahmann, MITRE

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- I have muted all participant lines for this introduction and the briefing.
- If you need to contact me during the briefing, send me an e-mail at sosecie@mitre.org.
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- We will hold all questions until the end:
  - I will start with questions submitted online via the CHAT window in Teams.
  - I will then take questions via telephone; State your name, organization, and question clearly.
- If a question requires more discussion, the speaker(s) contact info is in the brief.

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2020-2021 System of Systems Engineering Collaborators Information Exchange Webinars

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November 17, 2020

Achieving System-of Systems Interoperability Levels Using Linked Data and Ontologies

Dr. Jakob Axelsson

December 1, 2020

Achieving System Integration through Interoperability in a large System of Systems (SoS)

Mr. Oliver Hoehne

2021-2022 System of Systems Engineering Collaborators Information Exchange Webinars

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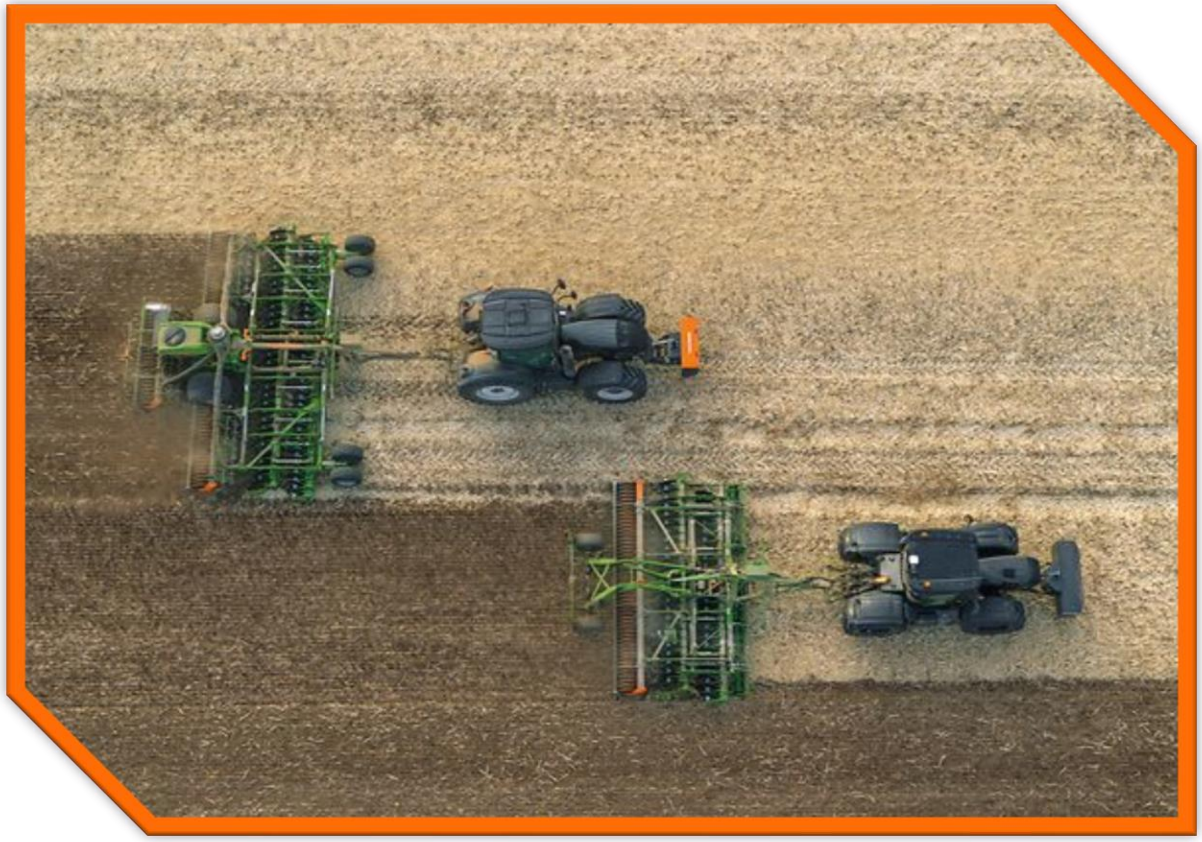
January 26, 2021
Addressing the Sustainable Development Goals with a System-of-Systems for Monitoring Arctic Coastal Regions
Evelyn Honoré-Livermore, Roger Birkeland and Cecilia Haskins

February 23, 2021
Interface Management- the Neglected Orphan of Systems Engineering
Paul Davies

March 9, 2021
Distributed Architecture for Monitoring Urban Air Quality: A Systems Engineering Approach
Adrián Unger, Tom McDermott and Philip Dewire

April 6, 2021
Holistic architecture description for a future Global Health Assurance Systems of Systems
Adrián Unger

Challenges for System of Systems in the Agriculture Application Domain



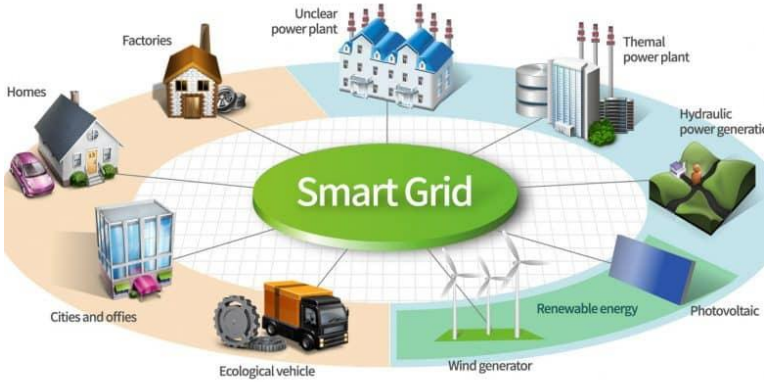
Authors: Dr.-Ing Benjamin Weinert, Dr.-Ing. Mathias Uslar

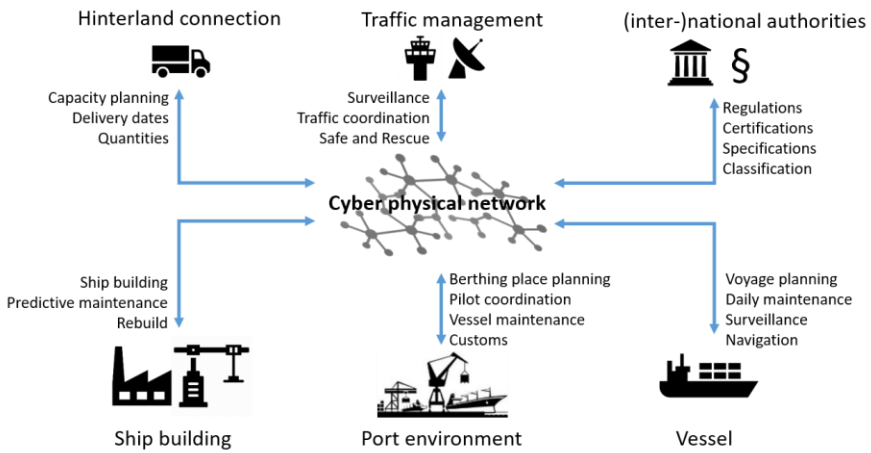
Overview

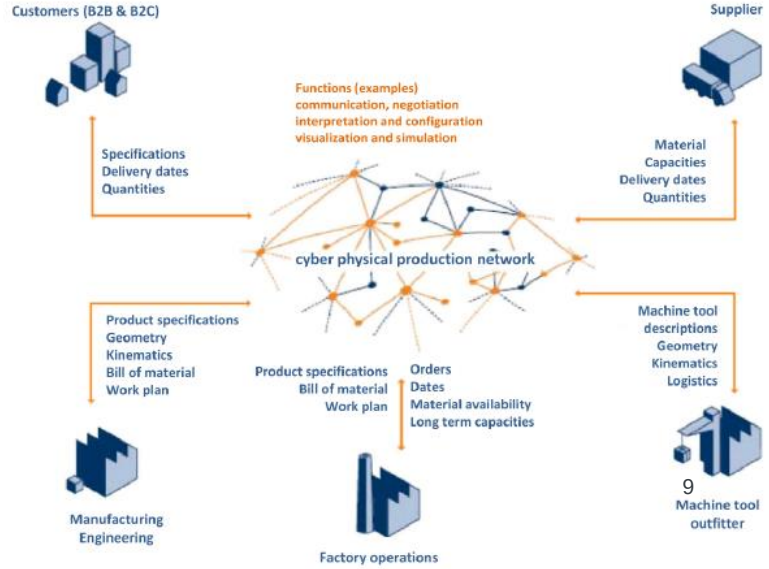
- Introduction
  - The Agricultural Domain
  - Problem statement
- Conceptual model for an interoperable communication framework
- Integration & challenges in the Agriculture Domain
- Domain Engineering
- Outlook
- Conclusion

Introduction

- ICT has become the basis for critical infrastructures in various application domains, for instance:
  - Energy supply
  - Maritime Transportation
  - Industry 4.0 / IoT
- Composition of different systems in a larger System of Systems (SoS)
  - Harmonized information exchange between existing systems
  - New technologies needed to deal with this complexity
  - Leads to unforeseen possibilities and emergent behaviour

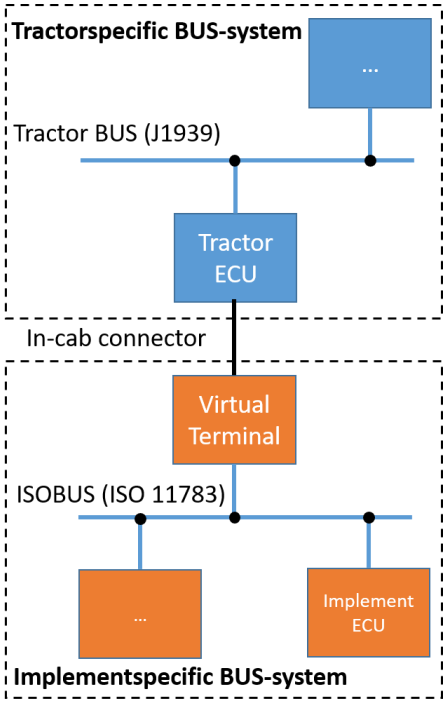






The Agricultural Domain

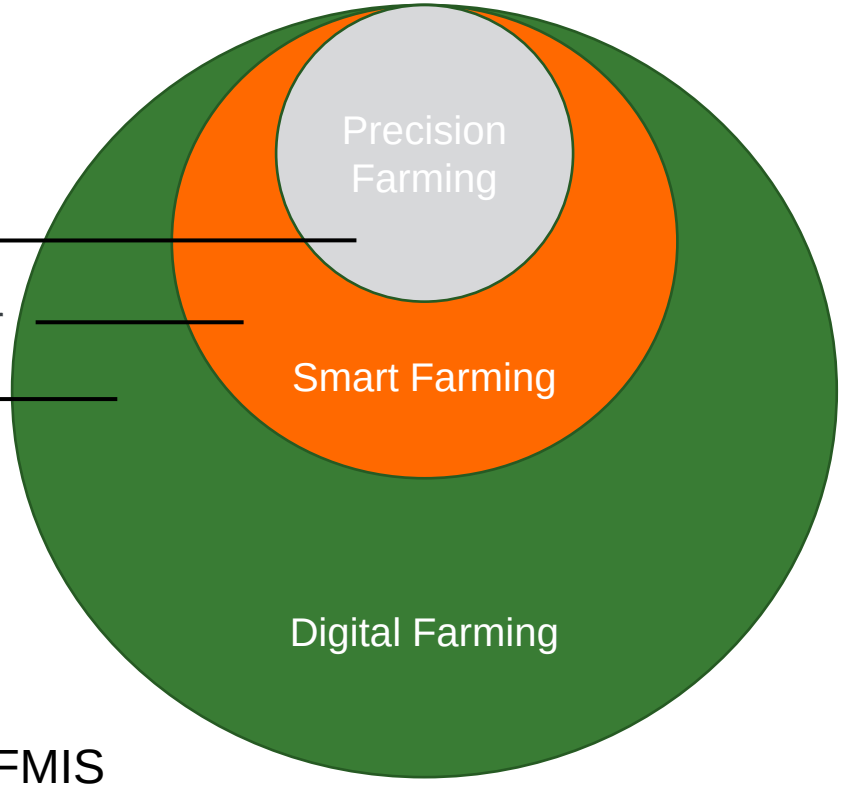
- Core of an agronomic application is performance of a measurement such as sowing, fertilising, spraying, etc. on a field
- Farmer coordinates the measurement and carries it out using a **tractor-implement combination**



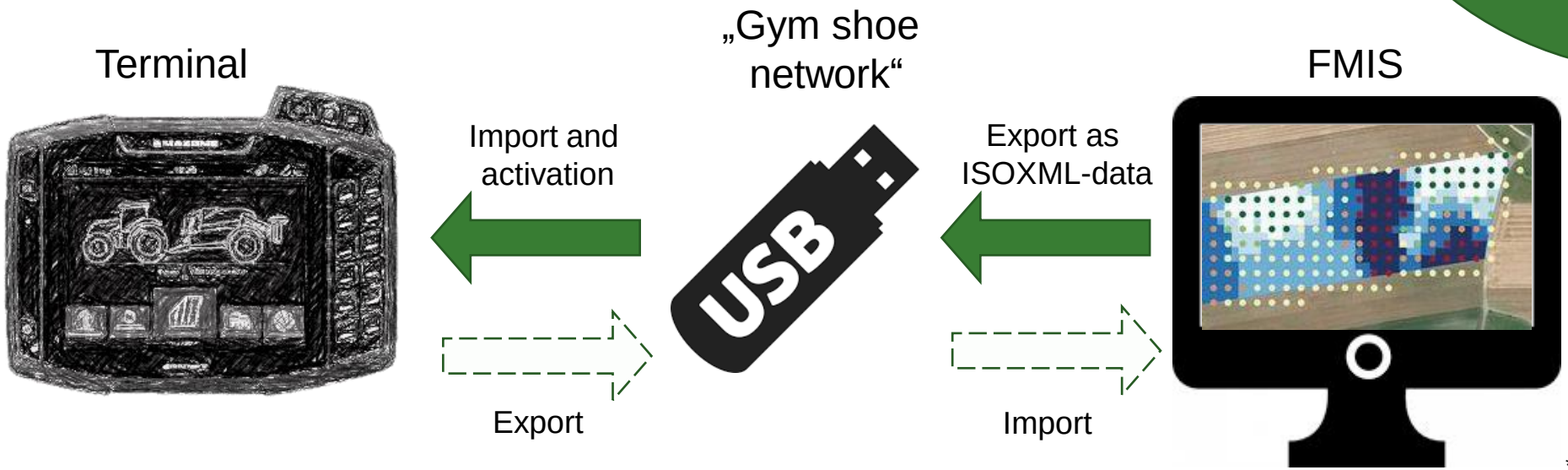
- Tractor and implement are equipped with a CAN-Bus based system
  - J1939 / **ISO 11783**
- Tractor and implement are controlled from the tractor cockpit using terminals
  - For control / monitoring of the tractor
  - For control / monitoring of the implement

The Agricultural Domain

- Area specific treatment (task data management)
- Automation of work processes / reduction of monotonous work and manpower
- Extends its predecessors with IoT, M2M, Cloud, AI, Robotic

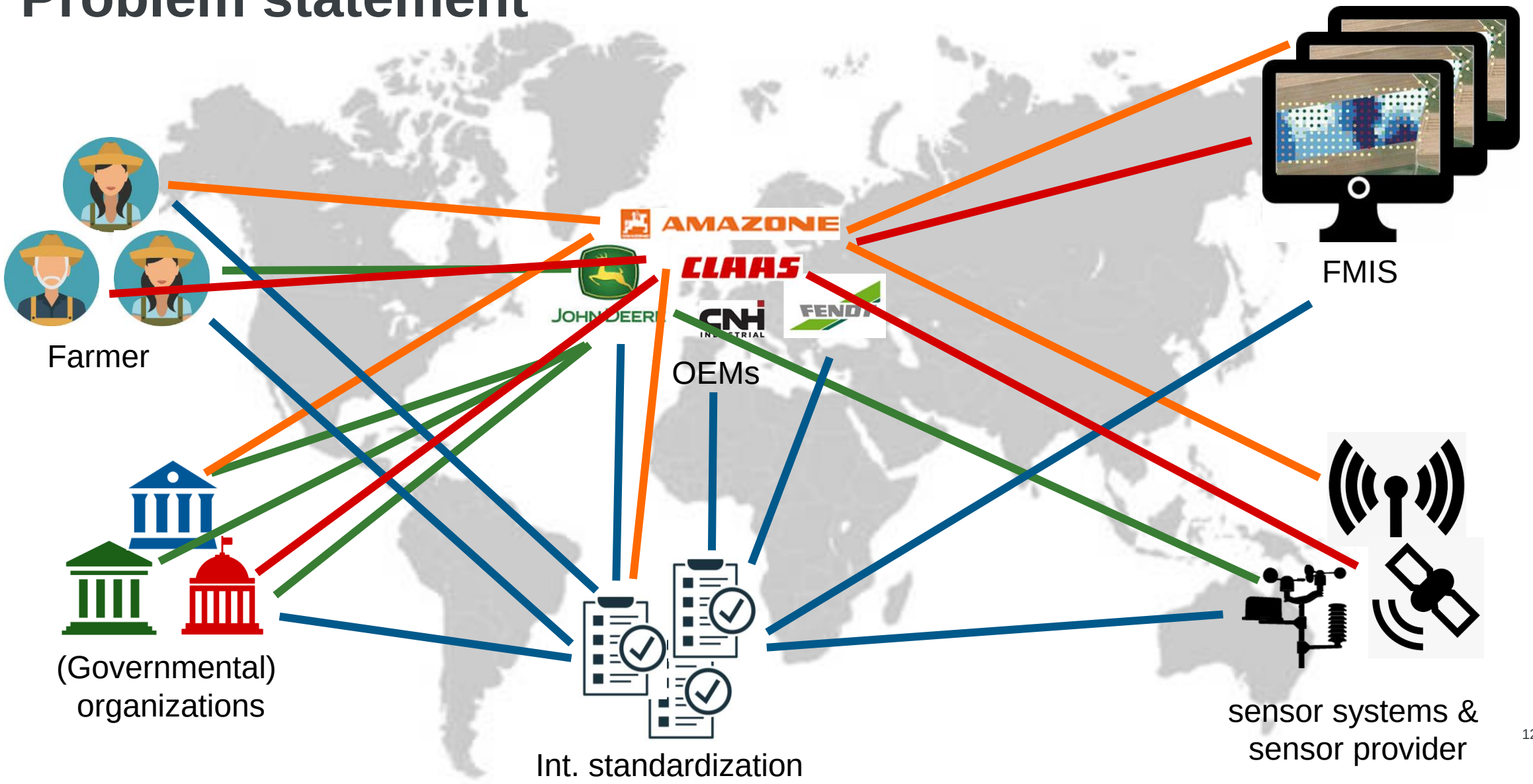


Task data management: Usage of area-based application maps
with e.g. application rates (driver, product, ..) for carrying out measures in a field



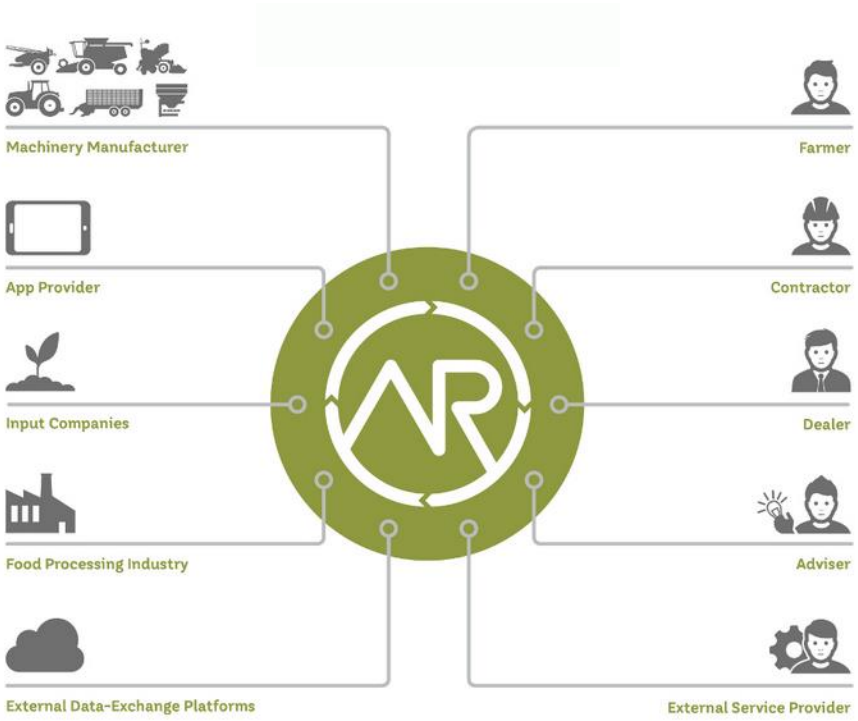
*FMIS: Farm Management Information System

Problem statement



Existing approaches

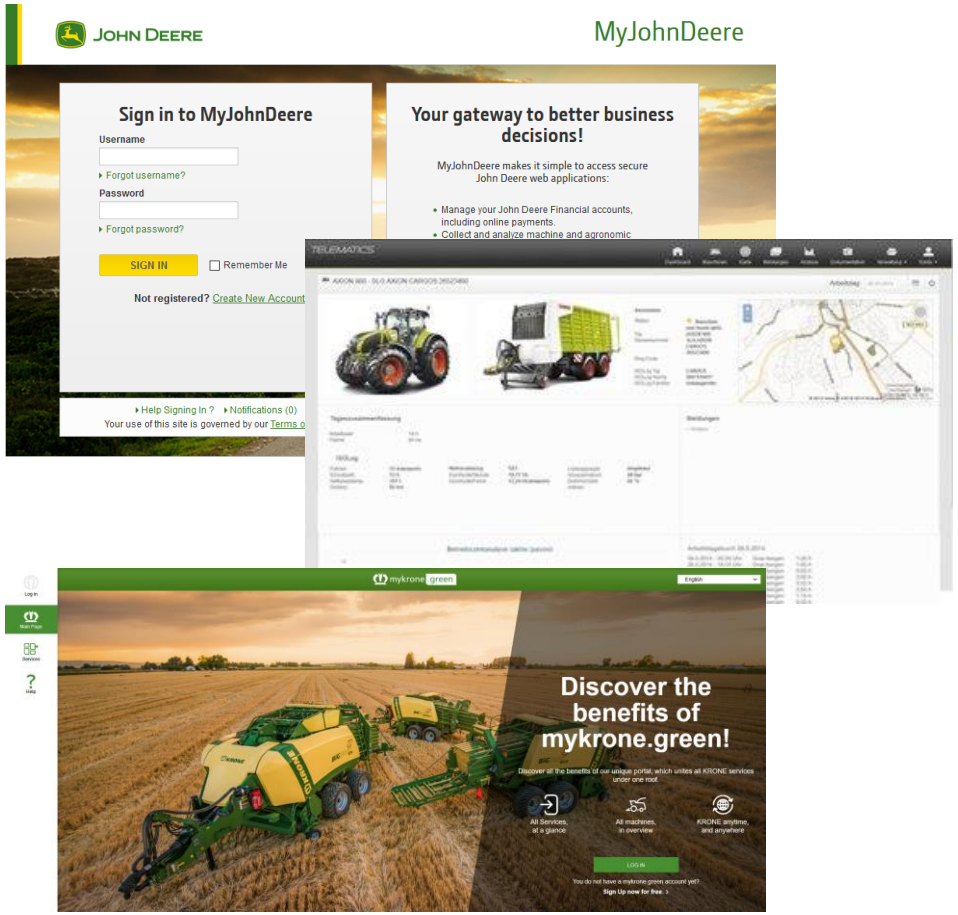
Agrirouter



- Manufacturer-independent
- Web-based central data exchange platform
- Open towards third parties (incl. Open API)
- Supported by governing company e.g. for maintenance, certification
- Enables the integration of different services to establish connection between sender and receiver
- Custom system-wide data structure with twelve message types
- Twelve message-types supported
- Routing through one communication mean
- Business model based upon governing company

Existing approaches

Vendor-specific platforms

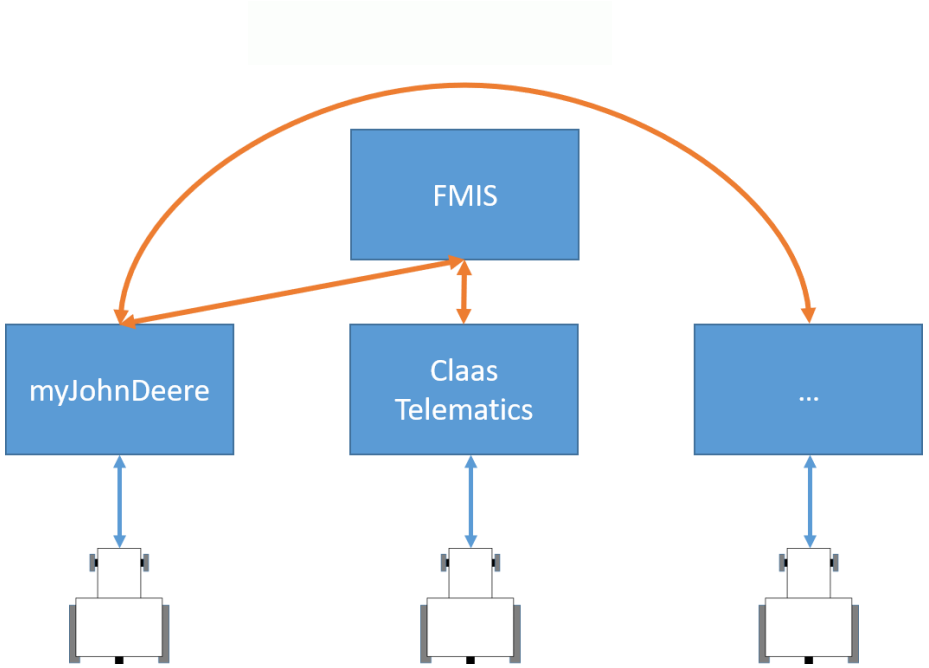


- For machine management
  - Tracking of machine movements
  - Fleet Management
  - Digital Twin
  - Additional services (e.g. „horsepower as a service“)

- **But**: A farmer does not have machines by only one OEM
- There are OEMs for tractors or implements with unique characteristics and stand-alone benefits

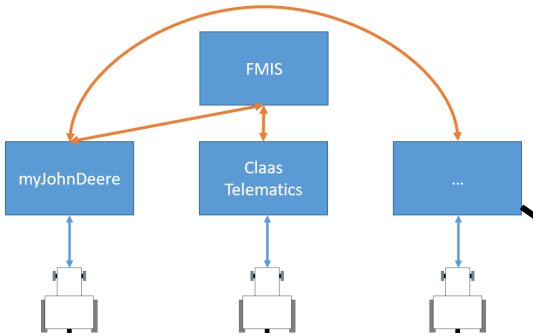
Existing approaches

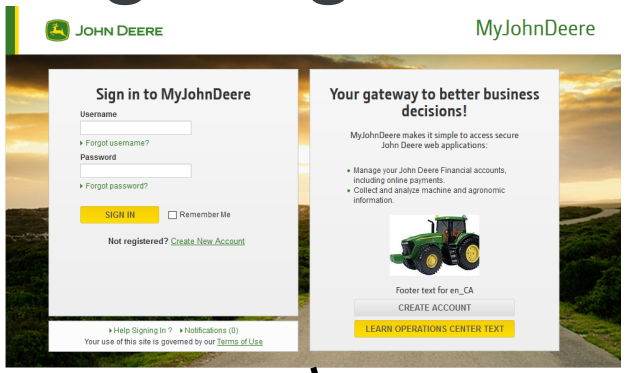
DataConnect

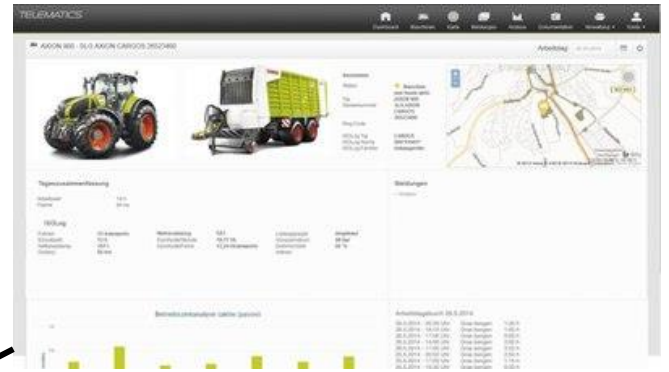


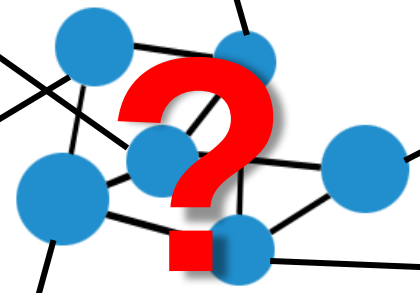
- Data exchange between vendor-specific platforms as Cloud-2-Cloud communication
- Communication between tractor-implement combination and vendor-specific platform is proprietary and individual
- Cross-Vendor semantically uniform information exchange between platforms
- Currently limited up to four message types for telemetric data
- Currently no Open API
- Supports different business models

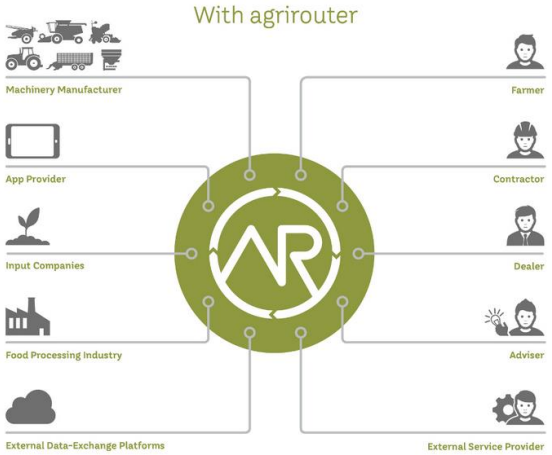
How to bring the things together

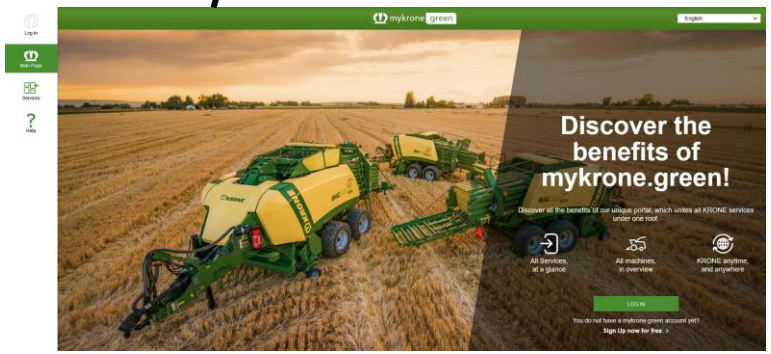


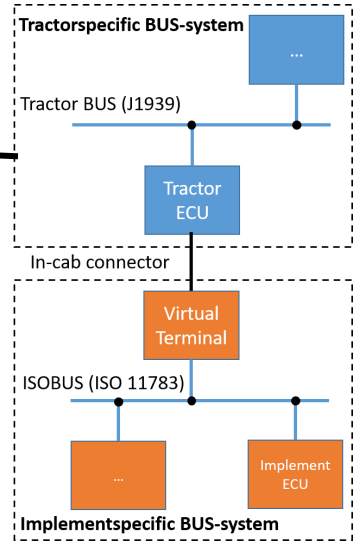












Idea: Adoption of solutions in other domains

The Maritime Connectivity Platform (MCP)

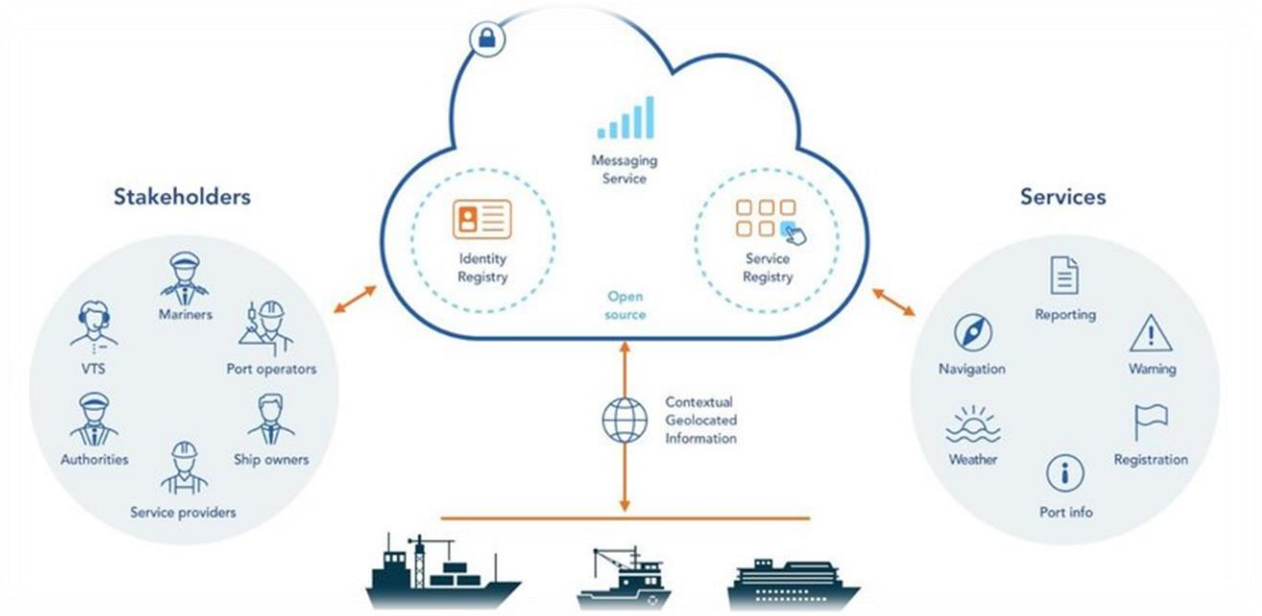


Figure: www.maritimeconnectivity.net

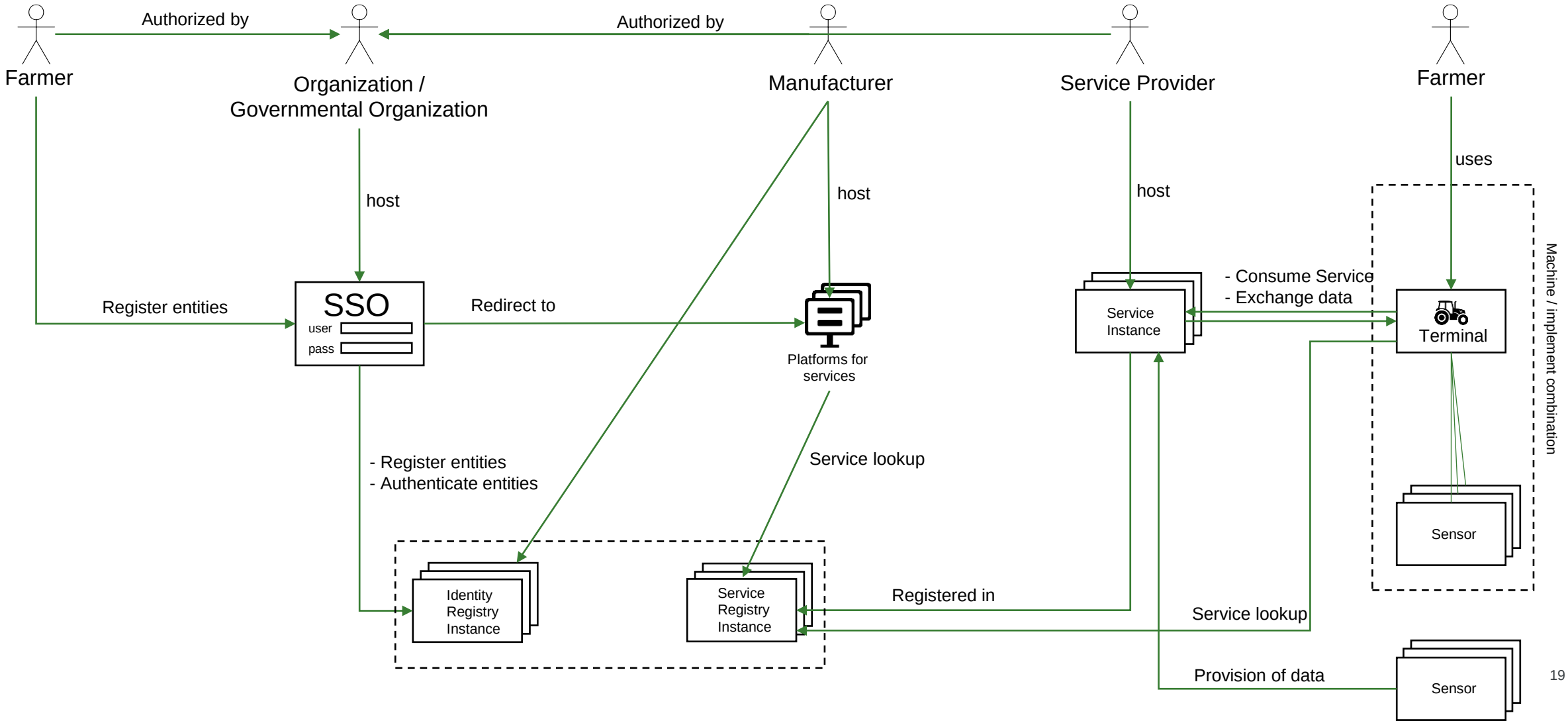
- Global unique identification of maritime actors
- Connection to port- and voyagemanagement
- Maritime communication
- Authentication of actors
- Service management
- Simple integration of e-Navigation / MSP services e.g. through web technologies
- Interoperability between services
- Building on existing communication infrastructure
- Security
- Existing maritime services can be migrated
- Reduces costs for use / operation of different platforms

Conceptual model for an interoperable communication framework

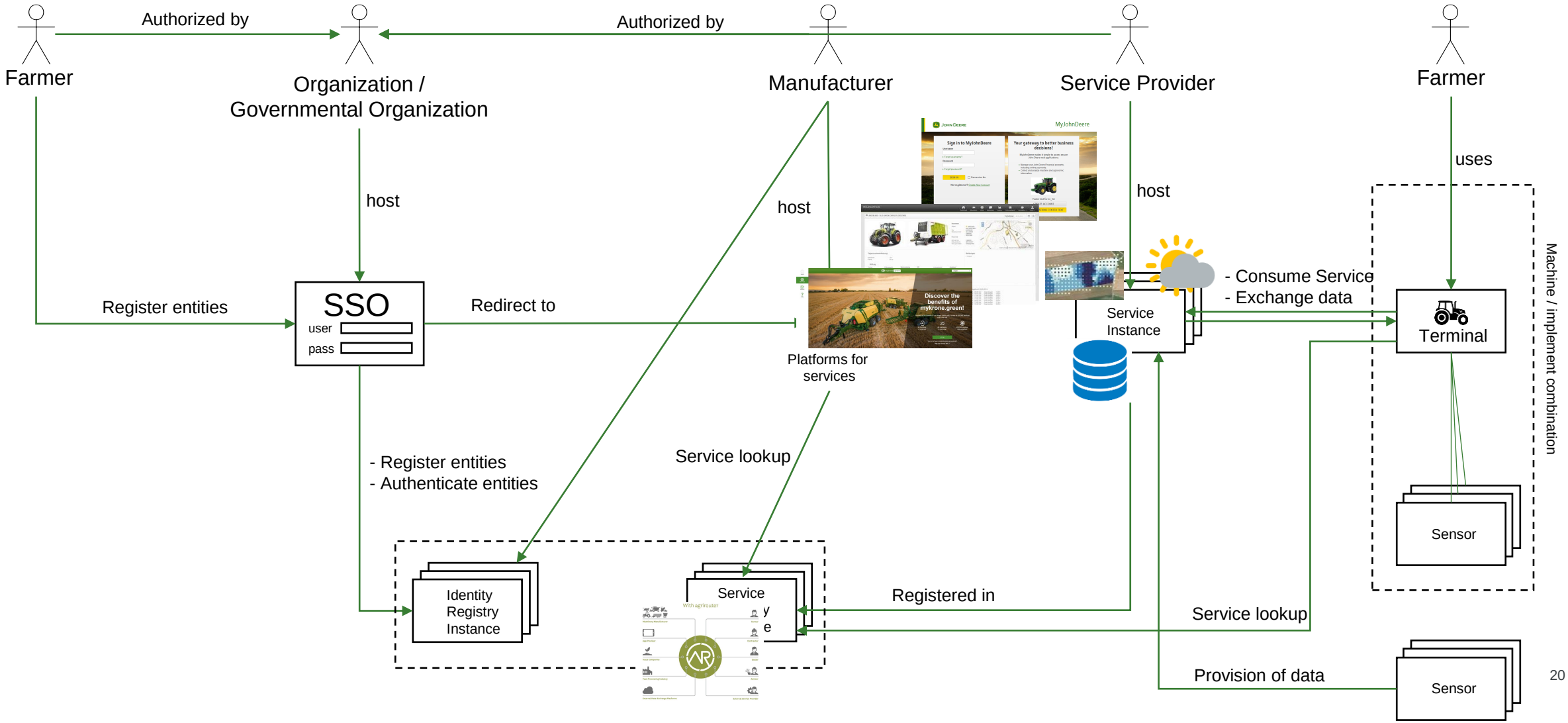
- Vendor-neutral provision of a user-oriented platform
- Consideration of existing approaches
- Provision of different **OEMs**, their **structures** and **business models**
- Service-oriented architecture to integrate third parties such as as FMIS-provider
    - Technical services could be:
        - FMIS Task data exchange
        - Documentation of measures
        - Livestreaming of geo-located weather information

This infrastructure should not be understood as a stand-alone product, but rather as a holistic communication framework in which agricultural actors can register, discover and directly use technical services.

Conceptual model for an interoperable communication framework

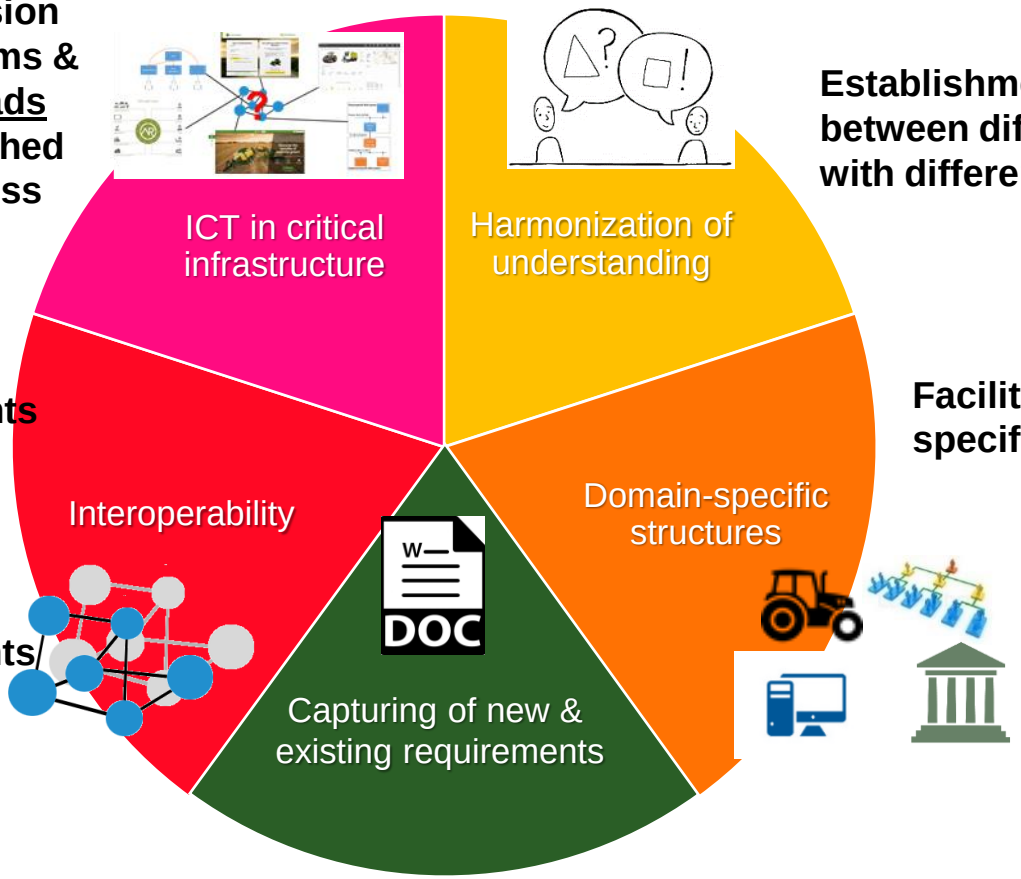


Conceptual model for an interoperable communication framework



Integration & challenges in the Agriculture Domain

Smart / Digital / Precision Farming, OEM platforms & further regulations leads to changes in established operational- or business processes



Establishment of consistency between different stakeholders with different perspectives

Facilitation of domain-specific structures

Semantical requirements

Technology requirements

Functional requirements

Regulative requirements

General requirements for a holistic approach in the agriculture domain

How can we do a probabilistic verification of systems?

How can we model and simulate the interactions between independent systems?

How can we integrate socio-technical factors into systems and software engineering methods?

How can systems be designed to recover from failure?

How should coalitions of systems be regulated and certified?

How can we monitor coalitions of systems and what are the warning signs of problems?

How can we support the agile engineering of coalitions of systems?

How should shared knowledge in a coalition of systems be represented?

How can we manage complex, dynamically changing system configurations?

To what extent can coalitions of systems be selfmanaging?

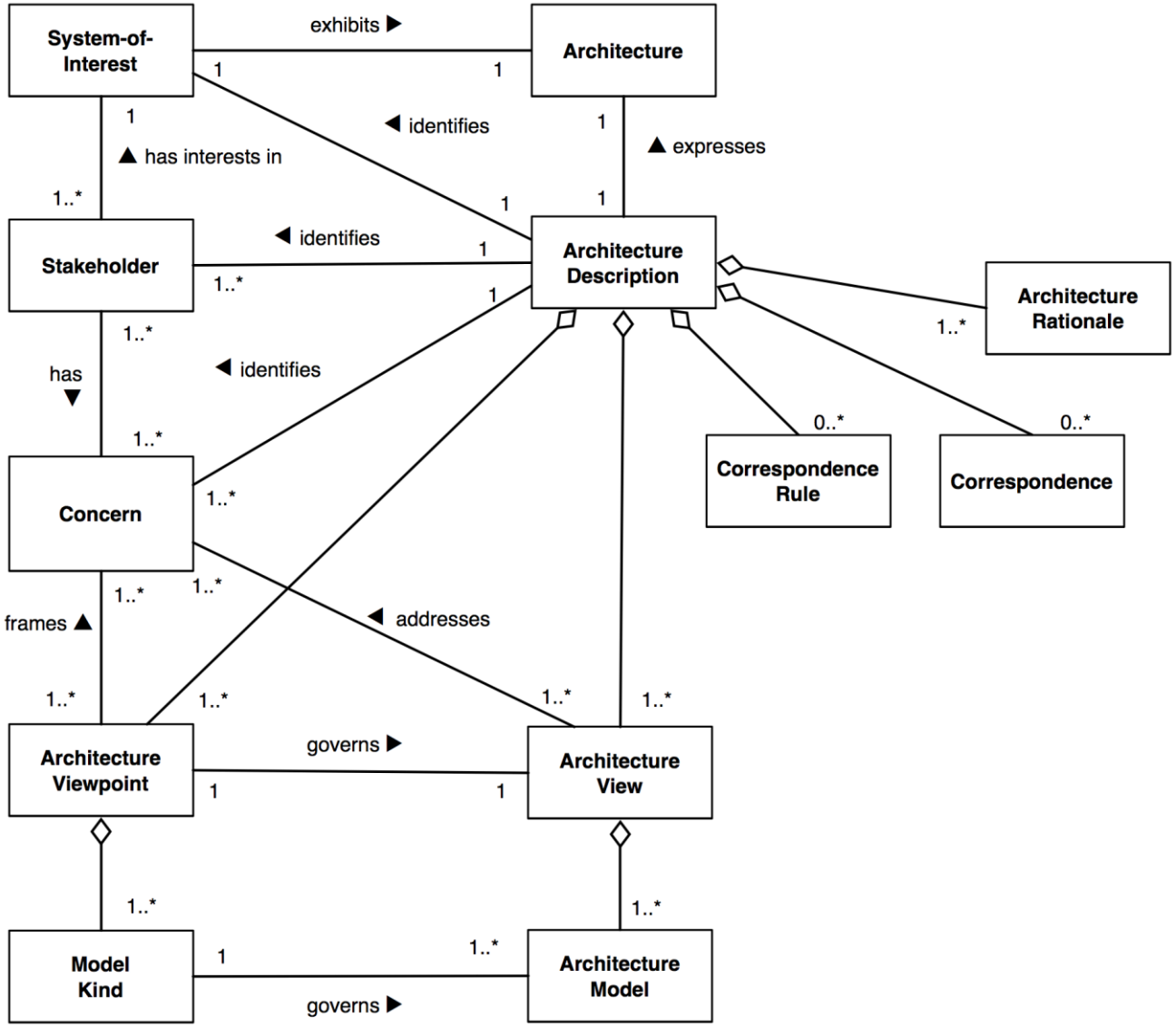
How can we integrate socio-technical factors into systems and software engineering methods?

¯_(ツ)_/¯

Requirements for a holistic approach

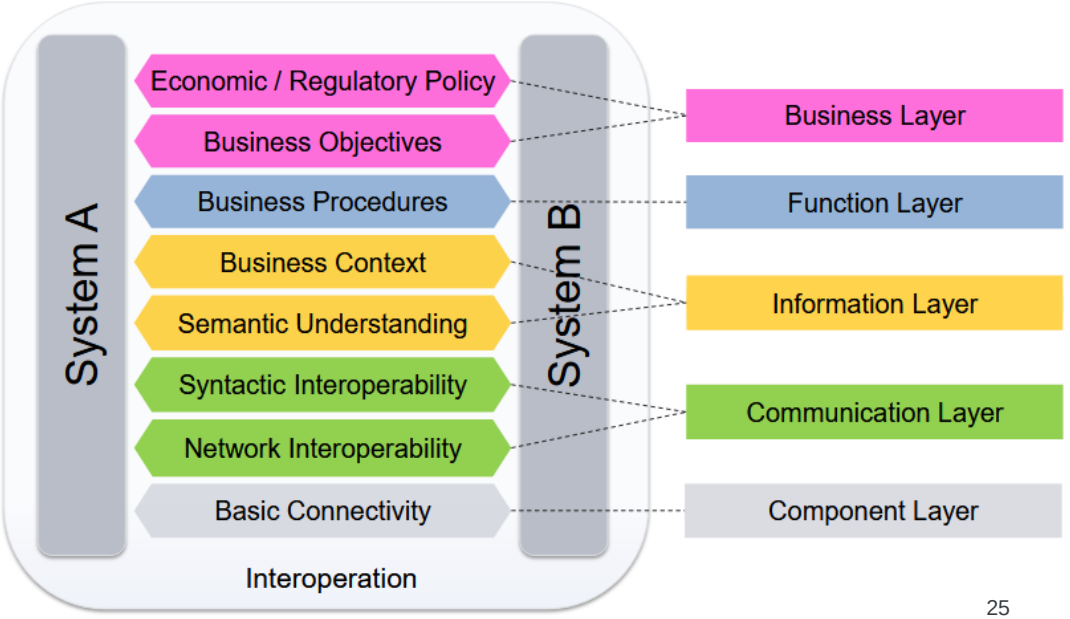
- Domains do have special terms, technology and regulations, but they share common characteristics respective basic technologies for technical solutions.
- Holistic approach requires:
  - A controlled vocabulary,
  - The shared understanding of technical dimensions,
  - acceptance of shared viewpoints for system development,
  - common and controlled way to document stakeholder requirements for the developers and solution architects and, finally, the implementers.

ISO 42010 - A Conceptual Model of Architecture Description

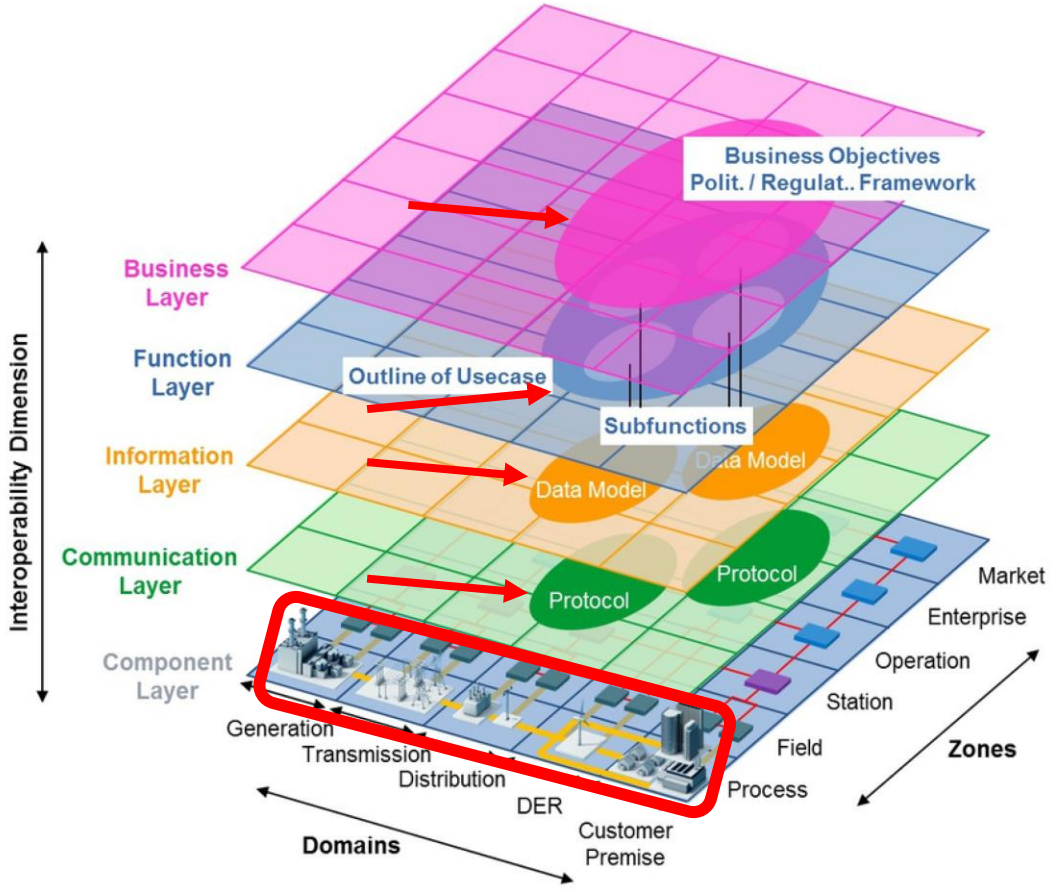


Using Domain Engineering

- Within the domain Smart Grid, one focus was put on the scope of **reference designation** for simple alignment of key characteristics and architecture viewpoints between blueprints (e.g. to identify interoperability issues across interdisciplinary architecture models)
- We know **reference designation** from every days life:
  - Adresses of buildings, floors, rooms. Finer granularity going to the solution
- In the M/490 EC mandate on Smart Grids, the SGAM was created in order to define dedicated viewpoints on technical solution for Smart grids and properly discuss in correct common terms about their scope



Domain Engineering – the SGAM



Reference designation system for a technical solution

- Value creation chain
- Automation pyramid
- Interoperability dimension

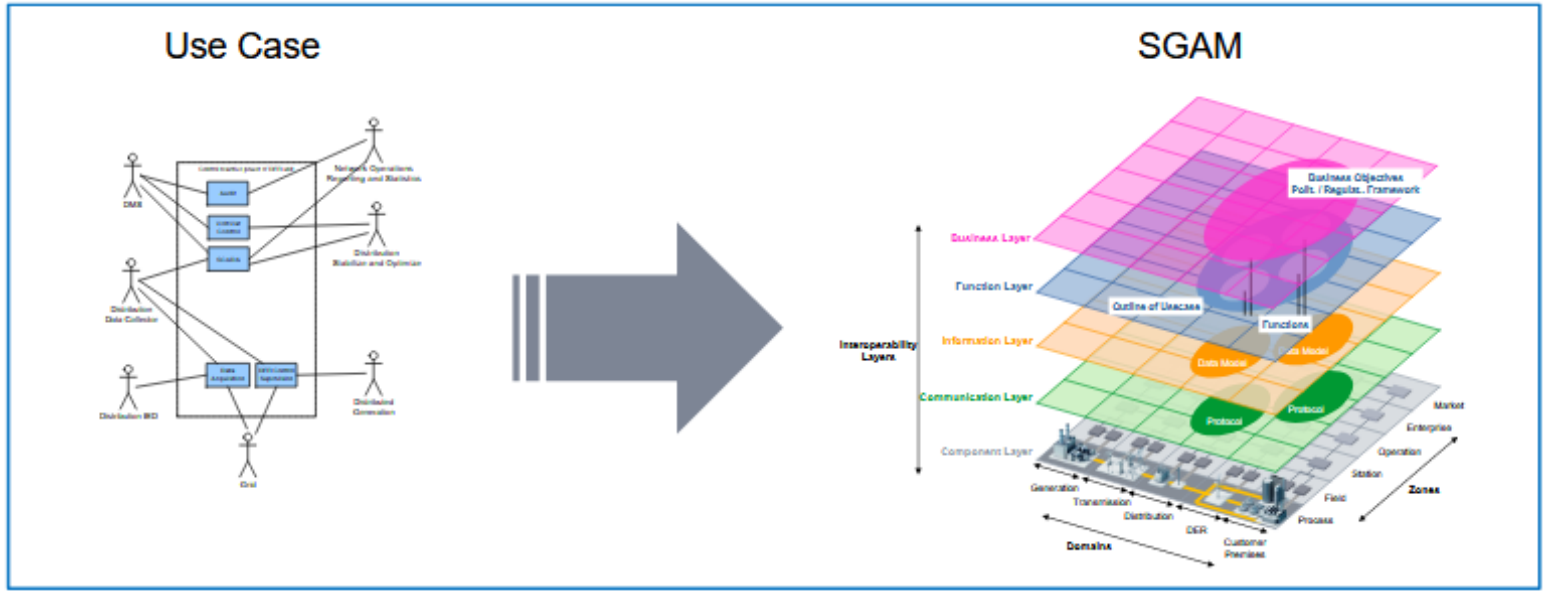
Focus is on exploded view of a solution in order to facilitate the discussion of the so called use case

Domain Engineering Examples

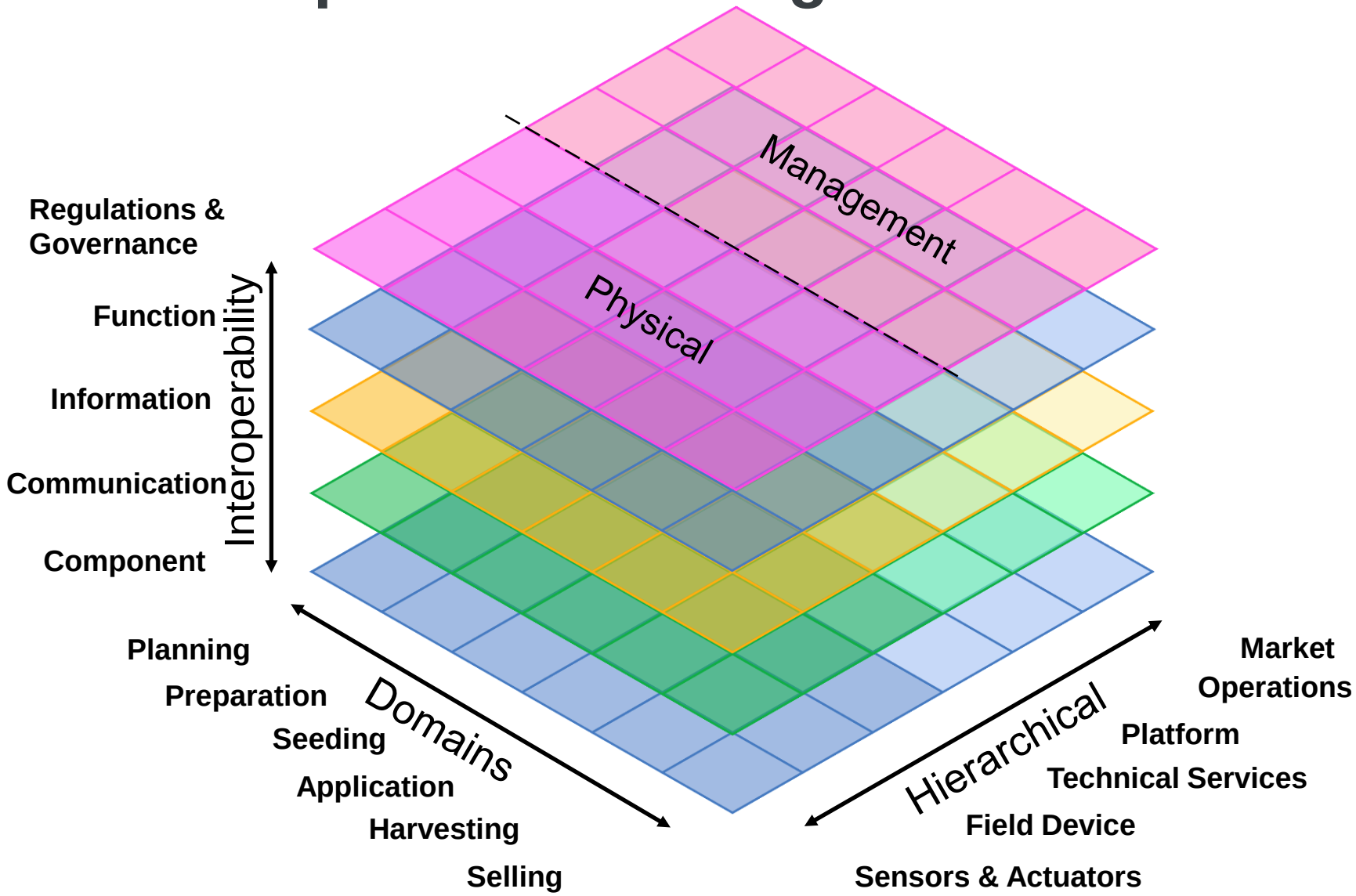
- **RAMI 4.0**: The RAMI 4.0, Reference Architecture Model Industrie 4.0 (Industry 4.0), was developed by the German Electrical and Electronic Manufacturers' Association (ZVEI) to support Industry 4.0 initiatives.
- **MAF:** The Maritime Architecture Framework methodology is to close the gap between the generic e-Navigation strategy and the current architectural world in the maritime domain.
- **SCIAM:** In comparison to the SGAM, the interoperability layers are taken over, whereby it new layers include Supply/Waste Management,Water/Waste Water, Mobility Transport, Healthcare/AAL, Civil Security, Energy, Building and Industry.

Requirements elicitation

- Most important for eliciting the stakeholders needs
- Needs to foster a common understanding with common terms
- Must have a minimum viable subset of context and information needed to implement the envisioned business case
- Provides traceabilty for later stages in a project
- Can be standardized, e.g. like in the Smart Grid with IEC 62559 and IEC 62913



Outlook – Adoption of existing method



Conclusion

- The proposed communication infrastructure is characterized as an open approach using common technologies and therefore do not restrict participants to specific business models
- The combination of divergent ambitions and platforms such as the Agrirouter in a broader interoperable communication framework seems to be possible
- Integration of conceptual model in existing infrastructure is an issue
- Adoption of given methods for Domain Engineering in progress
- Further studies and implementations have to be done in order to prove the approach as useful

Thank you for your attention