

Experiences in Collecting Requirements for an AI-enabled Industry 4.0 Platform

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IIP-Ecosphere

Aim:

- 'Easy-to-use' AI in Industry 4.0 / industrial production
- Identify and tackle existing obstacles
- One main activity: AI-enabled Industry 4.0 platform



IIP-Ecosphere
Next Level Ecosphere for
Intelligent Industrial Production

18+ partner:

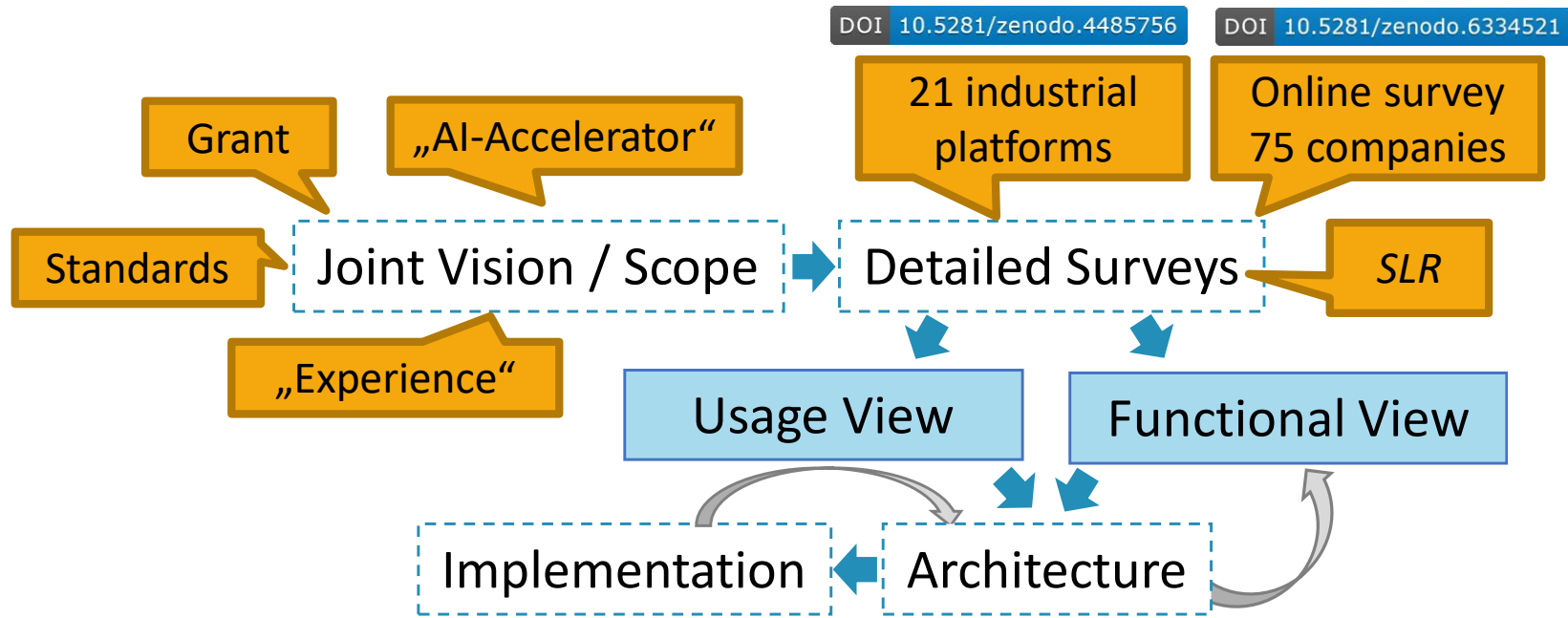


Goals

Core questions:

- Which demands shall drive the development of such a platform?
- How can we collect requirements in this context?
- Can we identify special requirements collection experiences?
- Are the requirements „ok“?

Approach

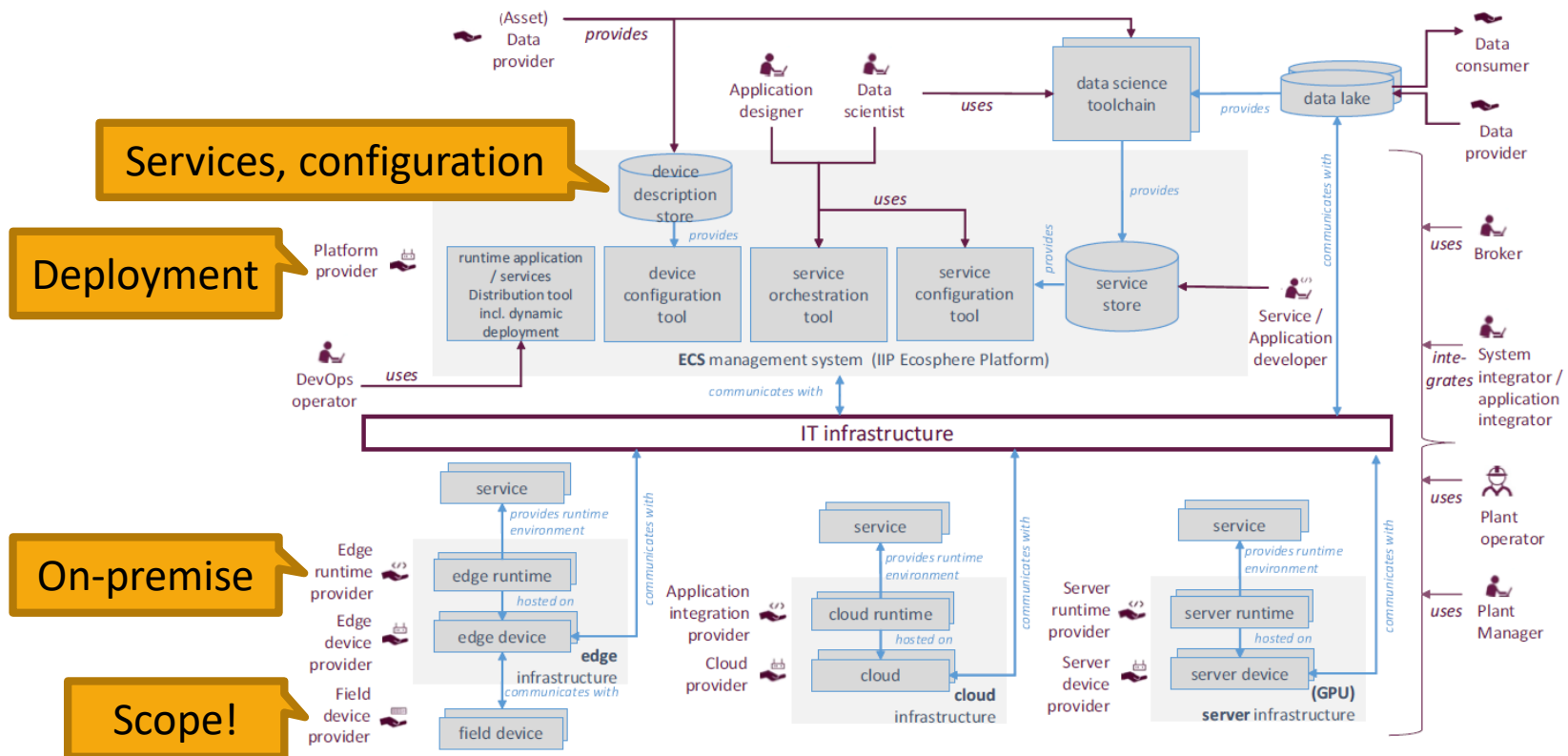


- Two views based on
 - German Standardization Roadmap Industry 4.0
 - Industrial Internet Reference Architecture (IIRA)
 - Reference Architecture Industry 4.0 (RAMI 4.0)

H. Eichelberger, H. Stichweh, C. Sauer, Requirements for an AI-enabled Industry 4.0 Platform – Integrating Industrial and Scientific Views, SOFTENG 2022, pp 7-14

Usage View (1)

- Origin: LNI 4.0 Edge Configuration View
- Sources: Workshops and iterative discussions
- Extended System under Consideration (SuC):



Usage View (2)

- Further specific topics:
 - Pre-deployment / testing
 - Self-description of entities via Asset Administration Shells
 - Data science to be considered orthogonal, not to be part of platform
- Summary:

Element	IIP-Ecosphere	LNI 4.0
Entities	18	5
Roles	19	7
Scenarios	43 (Edge) + 27 (AI)	27 (Edge)

- **Entities (18)**
- **Roles (19)**
 - *Edge device provider*
 - *Data scientist*
- **Activities for ECS management (7)**
 - Adding Entities (4)
 - Removing Entities (4)
 - Provision of Entities (8)
 - Provision of service and application template (4)
 - Service configuration and orchestration (6)
 - Setting up operational configurations (9)
 - Activities for (distributed) applications (8)
 - *Simulating the integration*
 - *Simulating the deployment*
 - *Visualizing the results*
- **Activities for AI services and processes (5)**
 - Activities for data exploration (5)
 - Activities for model training and evaluation (10)
 - *Training of AI models*
 - *Provision of intermediary model results*
 - *Continuous application of a model on new data*
 - *Re-calibration of model parameters*
 - Use of AI applications/services (2)
 - Analysis/Prediction of performance and accuracy (5)
 - *Provision of metrics for an application/service*
 - *Analysis of metadata to detect deviation/model drift*
 - Using AI services/applications manually, offline (2)

Functional View

- Second team
- Sources: Document analysis, interviews, workshops, focused questionnaire
- Documentation in terms of template sentences
- Special topics
 - AI model monitoring
 - Approval of runtime dynamics
- Initial: 131 top-level requirements, 116 sub-requirements

- General Requirements (12, 15)
- Connectors and Connections (10, 20)
- Heterogeneous, dynamic Deployment (15, 24)
 - R24. Resource properties/functions must be described as AAS.
 - R26. Platform must support on-premise deployment.
- Security (7, 6)
- Data Protection (24, 8)
- Central Storage Services (10, 21)
- Data Sharing (4, 8)
- Data Integration (10, 0)
- Configurability (9, 9)
 - R94. Platform must support automatic configuration validation.
 - R96. Configuration must include optional/alternative components/services.
- Optimized / Adaptive Deployment (8, 9)
- AI (Service) Toolkit (10, 27)
 - R110. The AI toolkit must define interfaces for AI components in industrial production.
 - R111. The AI toolkit must be extensible.
- Adaptive Service Selection (7, 6)
- Virtualization (4, 0)
- Application Support (11, 26)

Experiences, comparison

- Usage view
 - More interactive discussions
 - Scenario templates as guidance
 - Rather time consuming
 - Stakeholder clarifications
- Functional view
 - More technical discussions
 - Focus on application building
- Justification of scientific side needed!
- Overlap of the views: ~ 66%
 - Complementation of functional view
 - 141 top-level and 179 sub-requiremens
 - 16% quality requirements

Conclusions

- Multiple views can complement each other.
- Creating multiple views also increases the effort (2 views, $> 2 * \text{effort}$).
- Clarification of concepts, relations, ideas.
- First companies started to apply (a variant) of the approach.
- Concepts and ideas influence work of LNI 4.0.

Conclusions

- Requirements “ok”? Successful?

- ~ 50% realized
- Requirements for future
- UI, virtualization “underestimated”
- AI toolkit not trivial
- Some parts not delivered

- But

- Demonstrated on fairs etc.
- With significant (industrial) interest

