# A GENERAL APPROACH TO UNBUNDLE A LARGELY MONOLITHIC TIME-SERIES MANAGEMENT SYSTEM

September 28, 2023 | Ulrich Loup and Jürgen Sorg | Forschungszentrum Jülich

JÜLICH
Forschungszentrum

Data Infrastructure in Tereno since 2010 (Kunkel et al. 2013)
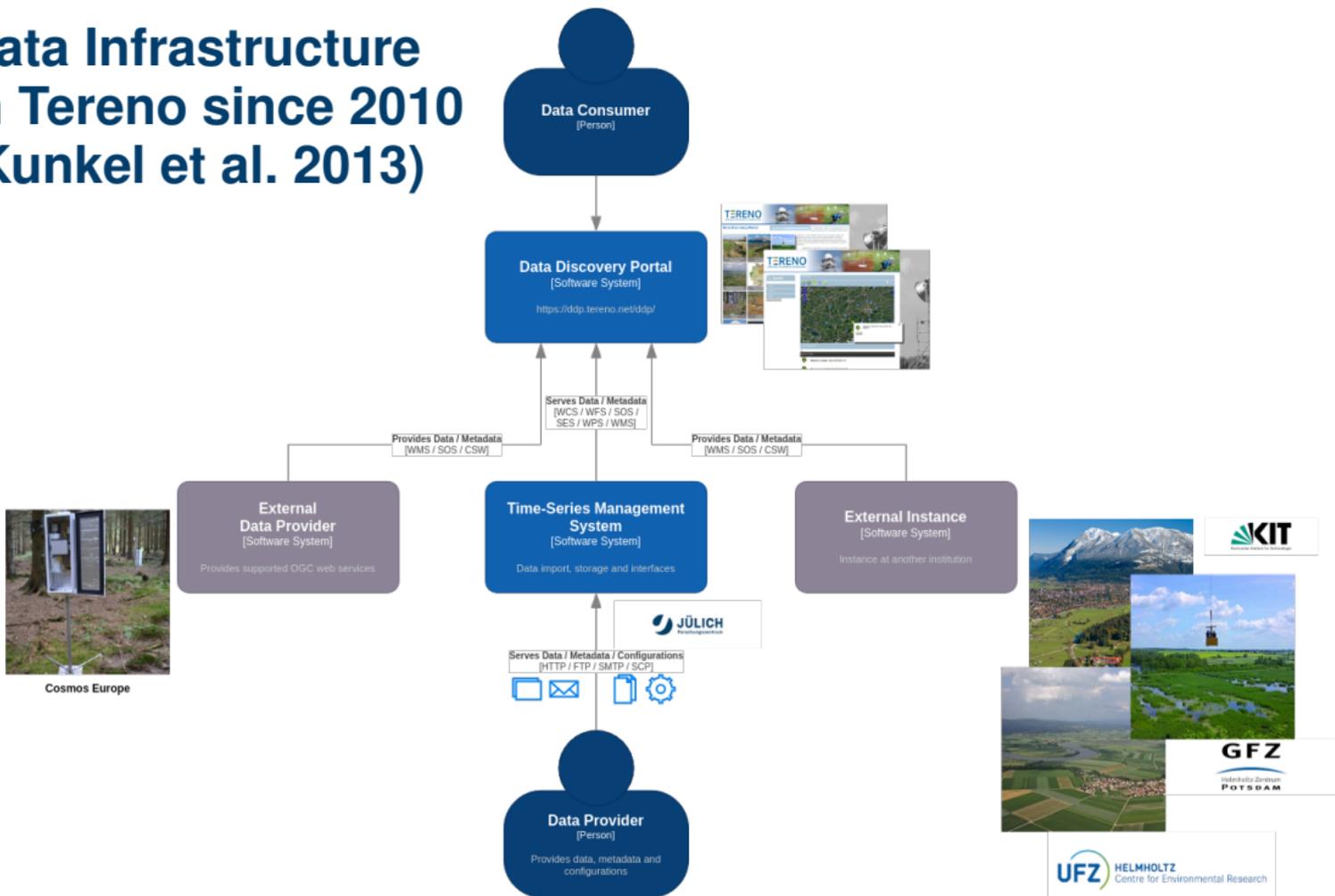
Data Infrastructure in Tereno since 2010 (Kunkel et al. 2013)

Lessons Learnt

- Sensor observation service (SOS): comprehensive data structure
- Time-series management (TSM) systems: independent developments

$\Rightarrow$

- No common metadata scheme
- No common vocabularies

$\Rightarrow$

- Inhomogeneous metadata
- Different data quality routines

Data Infrastructure in Tereno since 2010 (Kunkel et al. 2013)

Data Infrastructure in Tereno since 2010 (Kunkel et al. 2013)

DataHub
Research Field Earth and Environment

Data Consumer
[Person]

Data Discovery Portal
[Software System]
https://ddp.tereno.net/ddp/

Serves Data / Metadata
[WCS / WFS / SOS / SES / WPS / WMS]

Provides Data / Metadata
[WMS / SOS / CSW]

Provides Data / Metadata
[WMS / SOS / CSW]

External Data Provider
[Software System]
Provides supported OGC web services

Time-Series Management System
[Software System]
Data import, storage and interfaces

External Instance
[Software System]
Instance at another institution

Cosmos Europe

JÜLICH Forschungszentrum

Serves Data / Metadata / Configurations
[HTTP / FTP / SMTP / SCP]

Data Provider
[Person]
Provides data, metadata and configurations

GEOMAR

AWI

KIT

hereon Helmholtz-Zentrum

GFZ Helmholtz-Zentrum POTSDAM

UFZ HELMHOLTZ Centre for Environmental Research

Data Infrastructure in Tereno since 2010 (Kunkel et al. 2013)

Data Consumer
[Person]

DataHub
Research Field Earth and Environment

EUROPEAN OPEN SCIENCE CLOUD

NFDI4Earth

Data Discovery Portal
[Software System]
https://ddp.tereno.net/ddp/

Serves Data / Metadata
[WCS / WFS / SOS / SES / WPS / WMS]

Provides Data / Metadata
[WMS / SOS / CSW]

Provides Data / Metadata
[WMS / SOS / CSW]

External Data Provider
[Software System]
Provides supported OGC web services

Time-Series Management System
[Software System]
Data import, storage and interfaces

External Instance
[Software System]
Instance at another institution

Cosmos Europe

JÜLICH Forschungszentrum

Serves Data / Metadata / Configurations
[HTTP / FTP / SMTP / SCP]

Data Provider
[Person]
Provides data, metadata and configurations

GEOMAR

KIT

hereon Helmholtz-Zentrum

GFZ Helmholtz-Zentrum POTSDAM

UFZ HELMHOLTZ Centre for Environmental Research

Data Infrastructure in Tereno since 2010 (Kunkel et al. 2013)

Data Consumer
[Person]

Data Discovery Portal
[Software System]

External Data Provider
[Software System]
Provides supported OGC web services

Time-Series Management System
[Software System]
Data import, storage and interfaces

Data Provider
[Person]
Provides data, metadata and configurations

Cosmos Europe

Serves Data / Metadata
[HTTP / FTP / SMTP / SCP]

DataHub
Research Field Earth and Environment

Lessons Learnt

- Inhomogeneous metadata
- Different data quality routines

DataHub Initiative

- **F**indability
- **A**ccessibility
- **I**nteroperability
- **R**eusability
- NFDI4Earth, EOSC conformance

Data Infrastructure in Tereno since 2010 (Kunkel et al. 2013)

DataHub
Research Field Earth and Environment

EUROPEAN OPEN SCIENCE CLOUD

NFDI4Earth

Data Consumer
[Person]

Data Discovery Portal
[Software System]
https://ddp.tereno.net/ddp/

TERENO

External Data Provider
[Software System]
Provides supported OGC web services

Time-Series Management System
[Software System]
Data import, storage and interfaces

External Instance
[Software System]
Instance at another institution

Serves Data / Metadata
[WCS / WFS / SOS / SES / WPS / WMS]

Provides Data / Metadata
[WMS / SOS / CSW]

Provides Data / Metadata
[WMS / SOS / CSW]

Cosmos Europe

JÜLICH Forschungszentrum

Serves Data / Metadata / Configurations
[HTTP / FTP / SMTP / SCP]

Data Provider
[Person]
Provides data, metadata and configurations

GEOMAR

AWI

KIT Karlsruher Institut für Technologie

hereon Helmholtz-Zentrum

GFZ Helmholtz-Zentrum POTSDAM

UFZ HELMHOLTZ Centre for Environmental Research

Data Infrastructure in Tereno since 2010 (Kunkel et al. 2013)

Direct Implications for our TSM

- Sensor management outsourced in a stand-alone system
- Modern SensorThings API (STA) as main data/metadata interface
- Joint reference architecture (GFZ, UFZ, FZJ)

GFZ
UFZ
KIT
FZJ
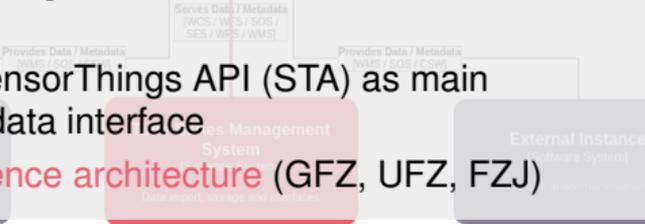
Reference TSM System Architecture
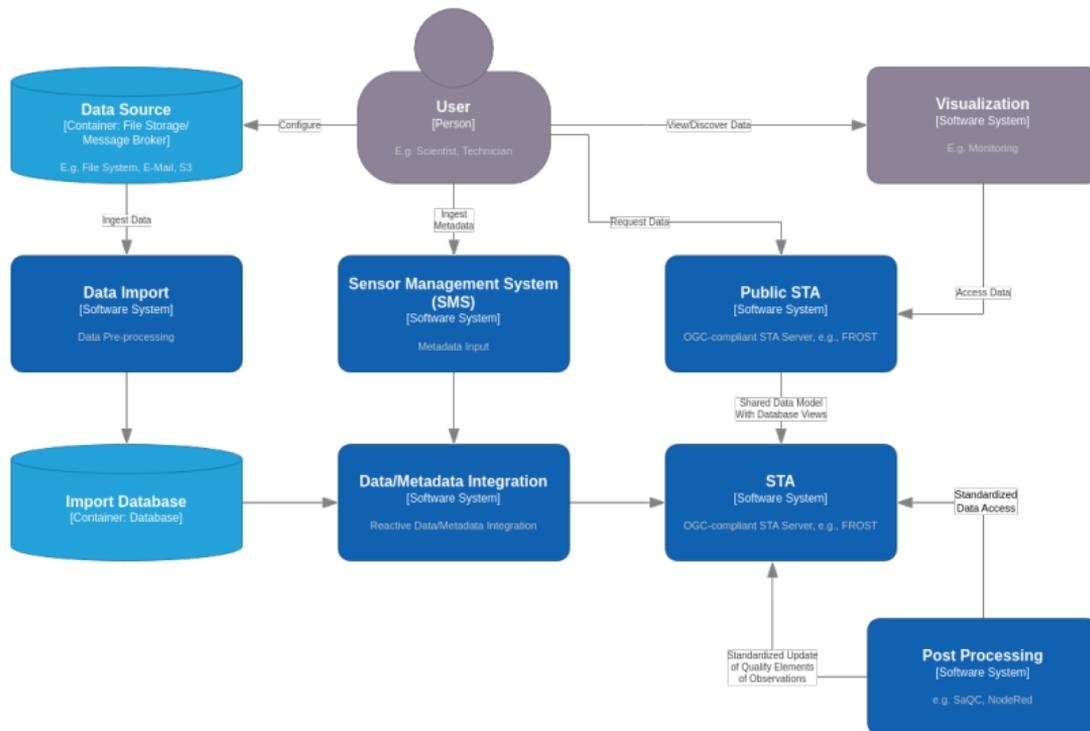
Current TSM System Architecture
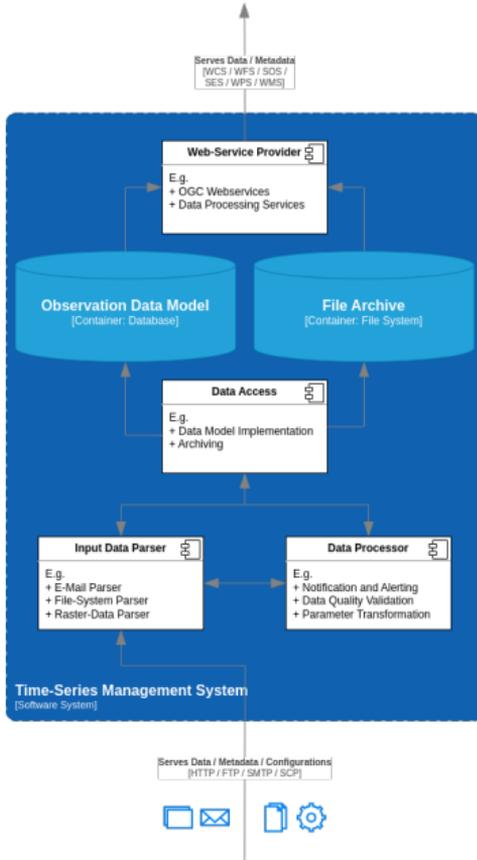
Monolithic Software System

- Data/metadata in a joint data model
- Integrated workflow for data processing and publication
- Changes only by the data manager (= developer)

$\Rightarrow$

- Complicated maintainability and extensibility
- Little user transparency/involvement
- Work distribution difficult, especially with new colleagues

$\Rightarrow$ Unbundling, i.e., creation of a highly modular, user-driven system

Microservice Architecture - What is it?
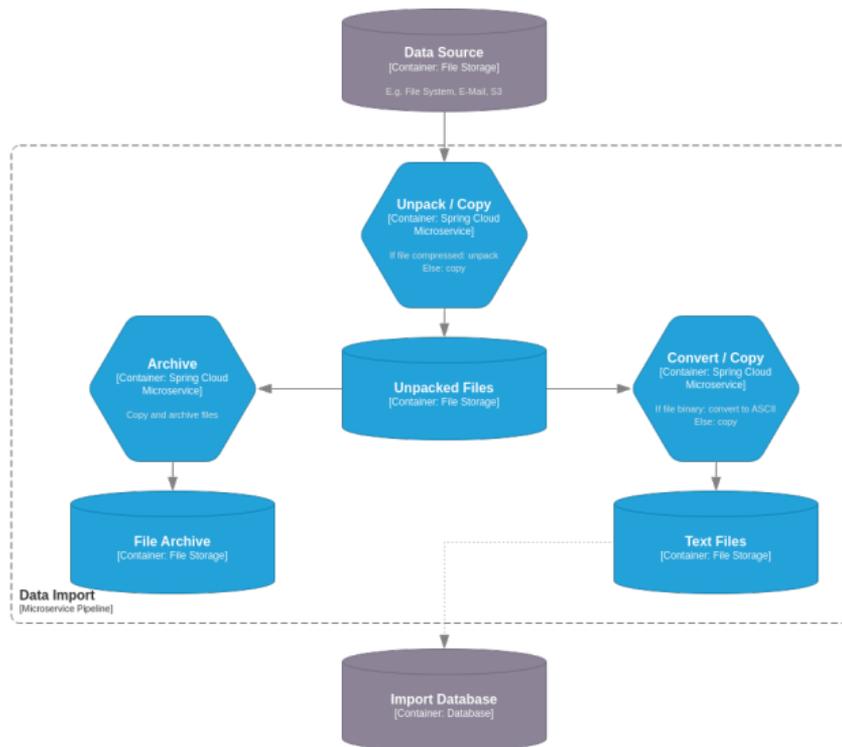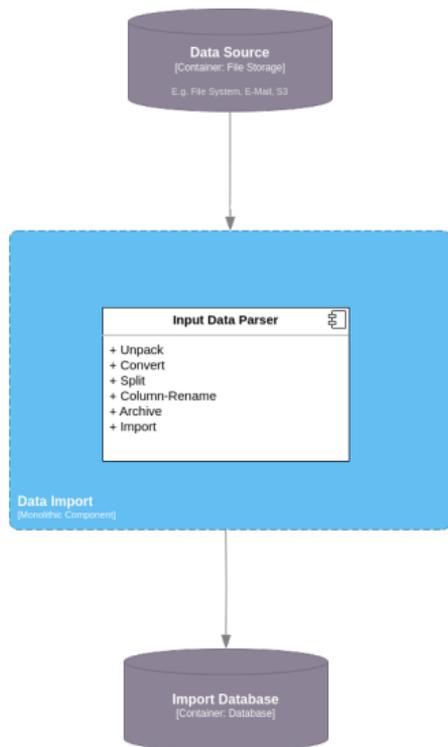
Microservice Architecture

Migration Key Points

- System functionalities $\rightarrow$ stand-alone services/processes
- Defined states between the services
- Combination in a pipeline/workflow
- Identification of the functionalities non-trivial (Bertolino et al. 2009; De Lauretis 2019)

Pros & Cons [cf. (Taibi, Lenarduzzi, and Pahl 2017)]

+ Improved maintainability/extensibility
+ Simplified work distribution/agile project management
+ Improved scalability
+ Extended testability/robustness
+ Easy technology experimentation/mix

- Migration difficult, especially for the data model
- Greater testing effort
- Performance should be considered
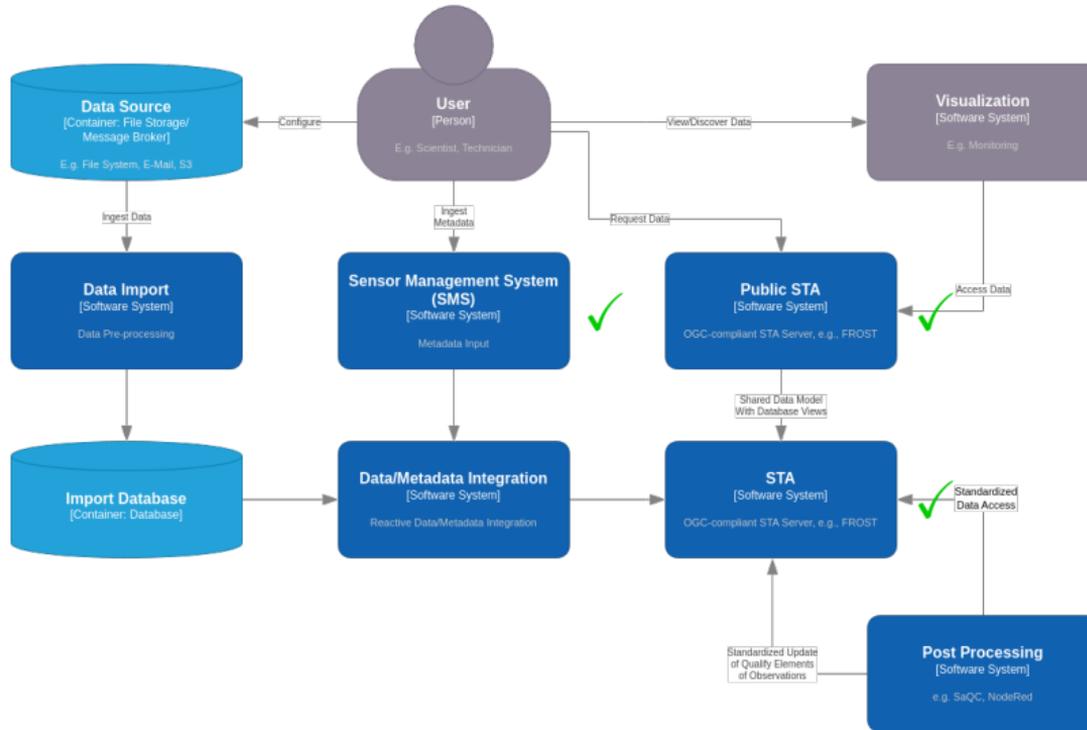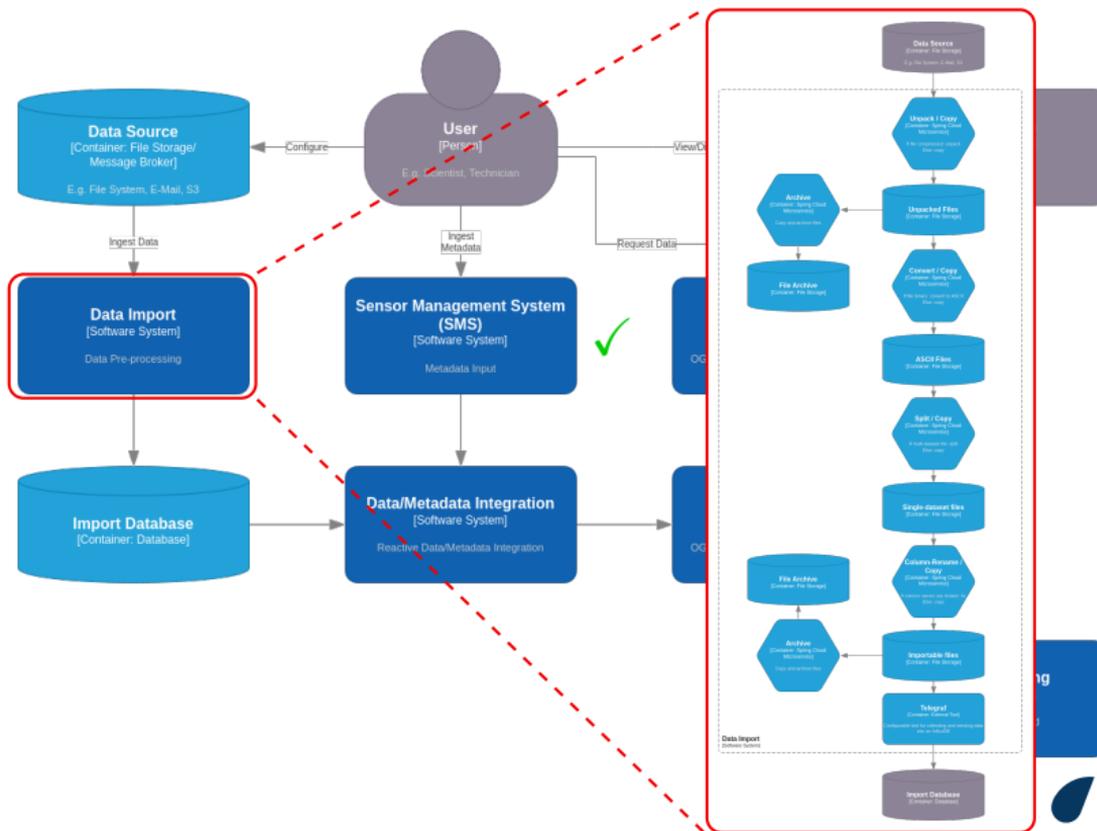
JÜLICH
Forschungszentrum

Implementation Details

Implementation Details

Implementation Details
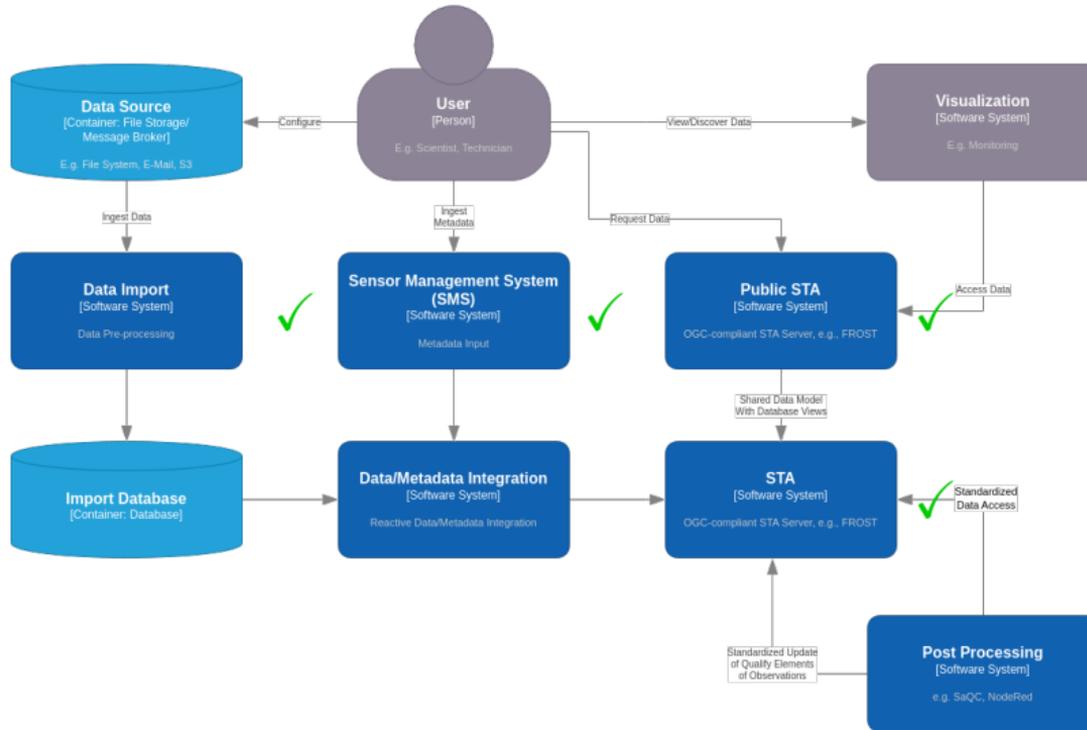
Implementation Details
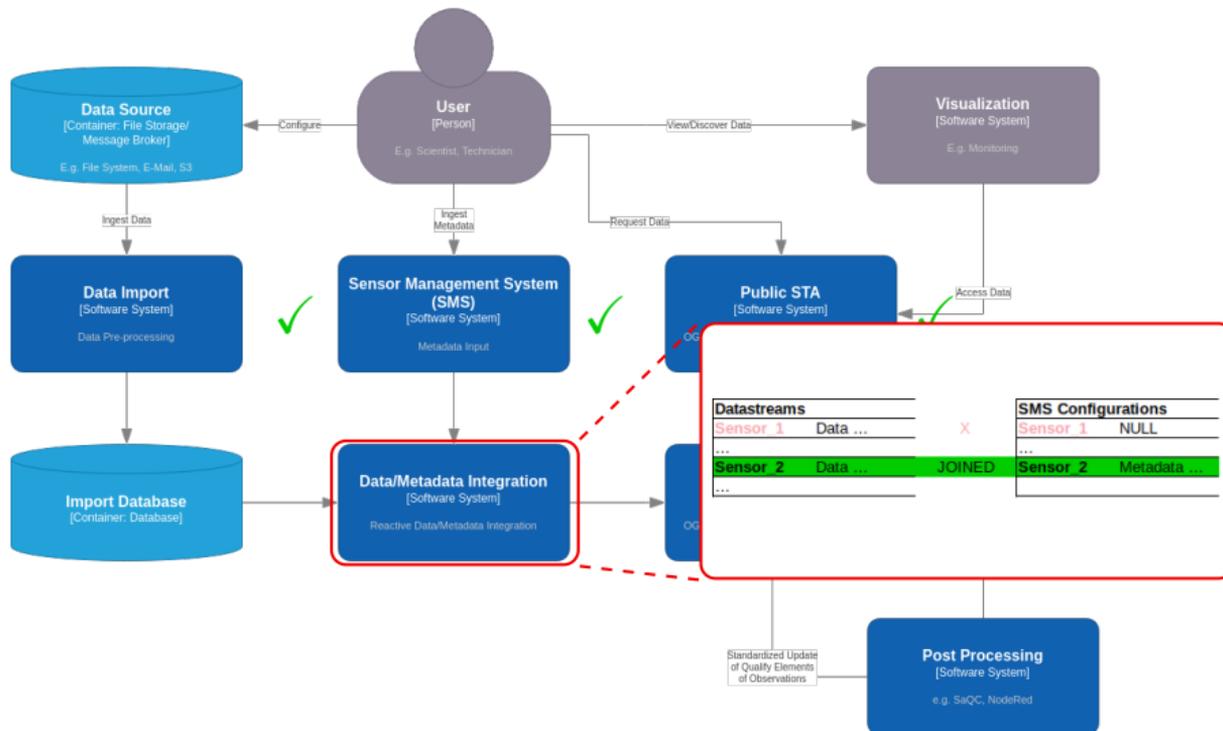
Implementation Details
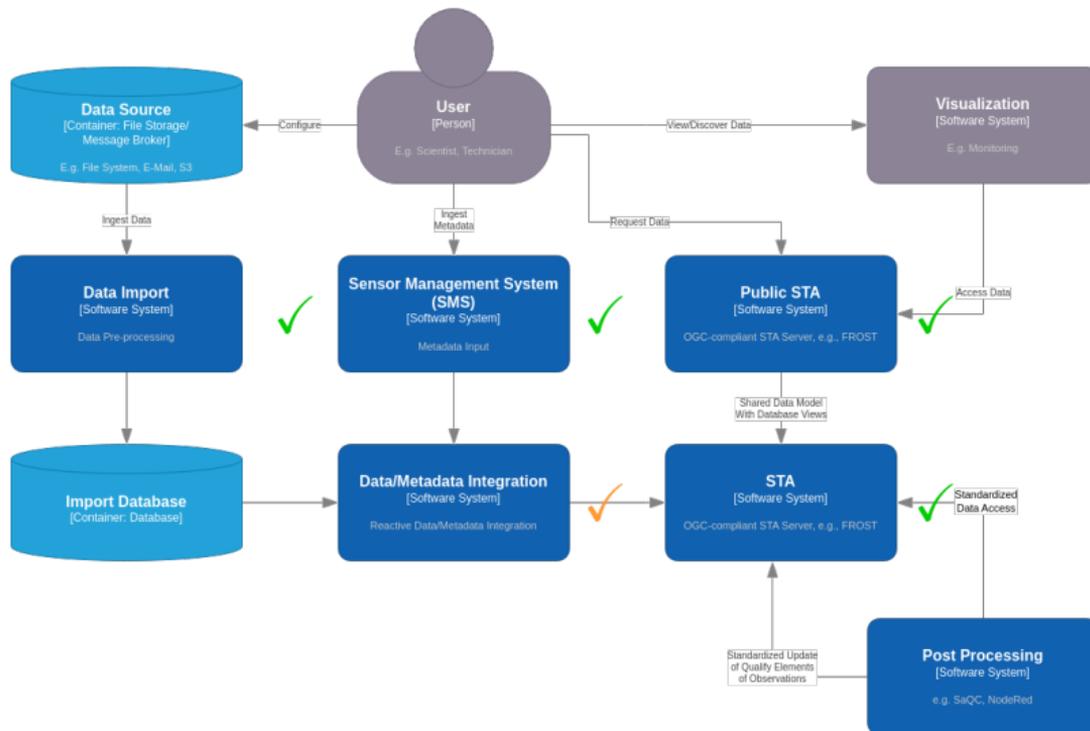
Implementation Details
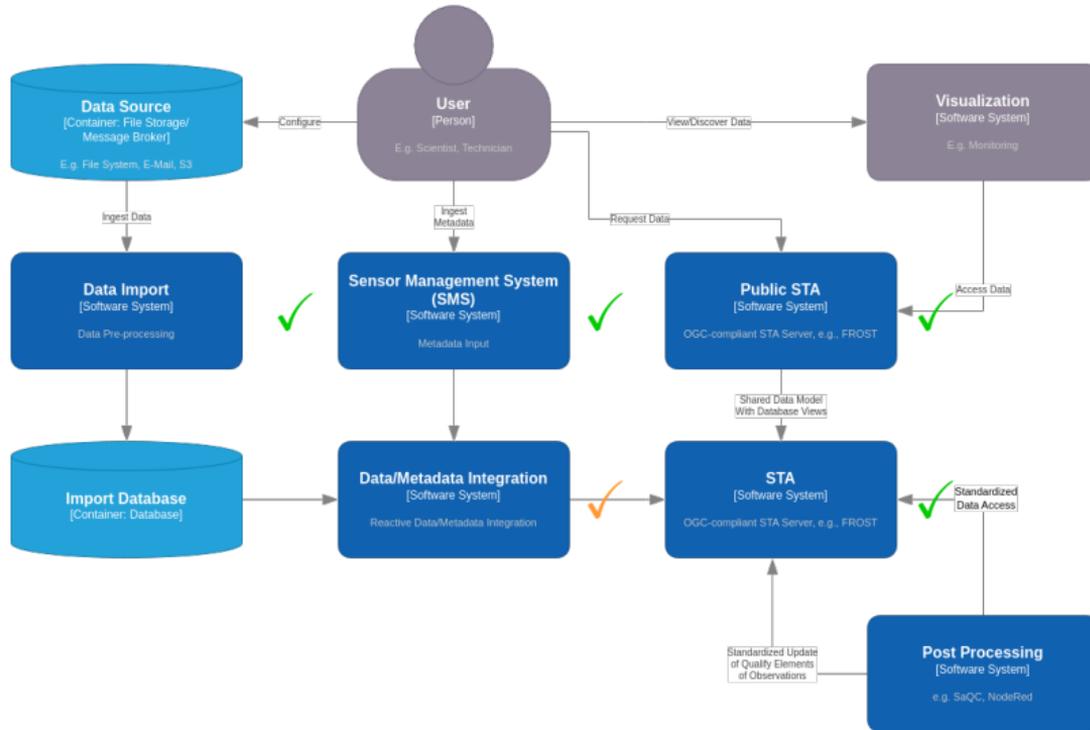
Conclusion for the Migration of TSM Systems

Intermediate States

- Defined states between the microservices catalyse the unbundling.

Separating Data and Metadata

- Keeping data and metadata in separate systems generates a new integration component.
- A simpler target data model can ease the integration step.

JÜLICH
Forschungszentrum

Outlook

Future Research

- Performance evaluation STA, comparison to SOS
- Post-processing based on STA
- Map service based on STA

Next Steps in TSM Development

- Data/Metadata integration
- SMS introduction to the users (October 2023)
- Migration of current metadata
- Regular SMS community meetings

JÜLICH
Forschungszentrum

Outlook

Future Research

- Performance evaluation STA, comparison to SOS
- Post-processing based on STA
- Map service based on STA

Next Steps in TSM Development

- Data/Metadata integration
- SMS introduction to the users (October 2023)
- Migration of current metadata
- Regular SMS community meetings

Thank you!

JÜLICH
Forschungszentrum

References I

📄 Bertolino, Antonia et al. (Aug. 2009). "Automatic synthesis of behavior protocols for composable web-services". In: Proceedings of the 7th joint meeting of the European software engineering conference and the ACM SIGSOFT symposium on The foundations of software engineering. ACM. DOI: 10.1145/1595696.1595719.

📄 De Lauretis, Lorenzo (Oct. 2019). "From Monolithic Architecture to Microservices Architecture". In: 2019 IEEE International Symposium on Software Reliability Engineering Workshops (ISSREW). IEEE, pp. 93–96. DOI: 10.1109/ISSREW.2019.00050.

📄 Kunkel, Ralf et al. (2013). "TEODOOR - A Spatial Data Infrastructure for terrestrial observation data". In: Proceedings of 10th IEEE International Conference on Networking, Sensing and Control, ICNSC 2013, Evry, France, April 10-12, 2013. IEEE, pp. 242–245. DOI: 10.1109/ICNSC.2013.6548744.

📄 Taibi, Davide, Valentina Lenarduzzi, and Claus Pahl (2017). "Processes, motivations, and issues for migrating to microservices architectures: An empirical investigation". In: IEEE Cloud Computing 4.5, pp. 22–32.

JÜLICH
Forschungszentrum

Appendix

TEODOOR Data Infrastructure (Kunkel et al. 2013)
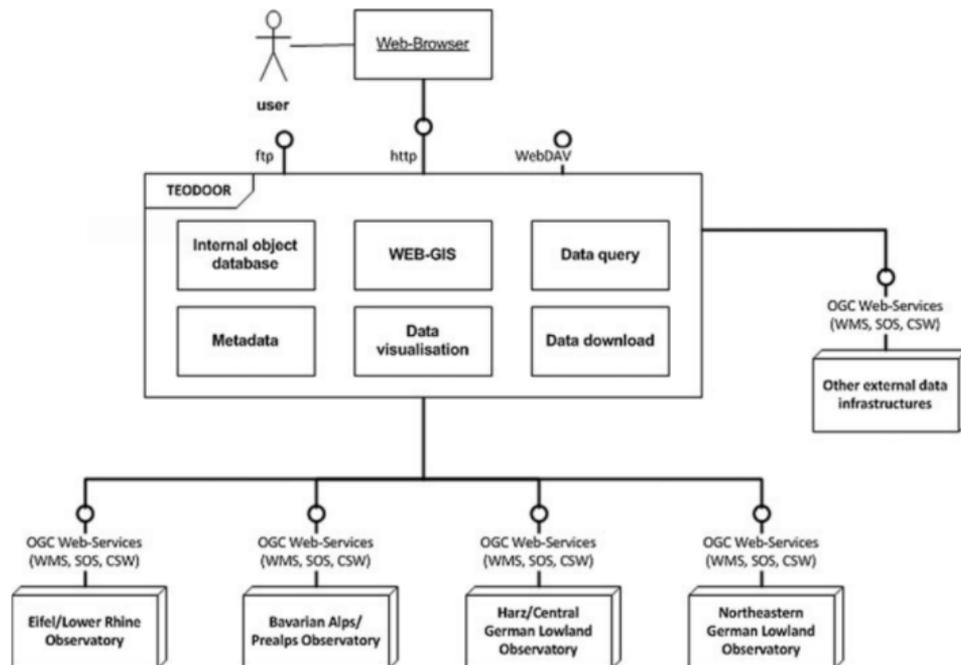
TEODOOR System Infrastructure (Kunkel et al. 2013)
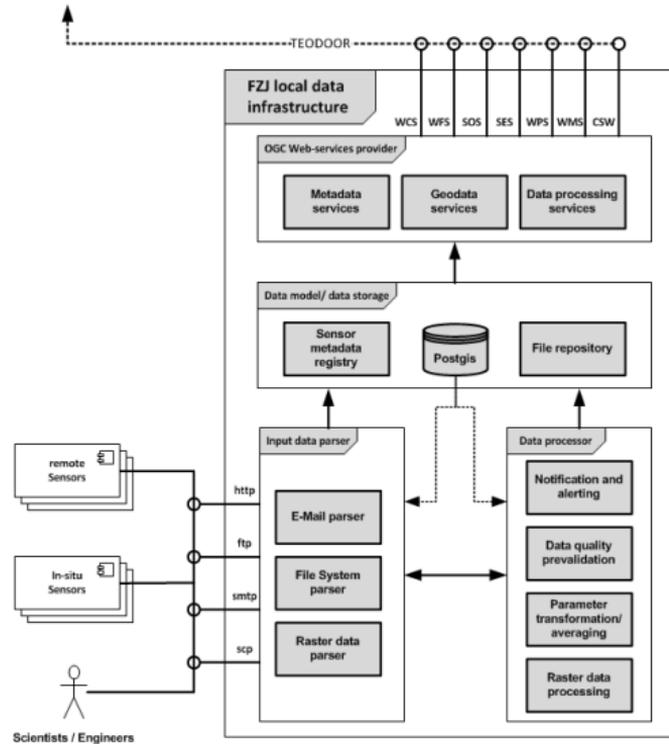
Microservice Architecture

What is a microservice?

- One process
- Often no threads
- Modular or not
- Deeply integrated data model
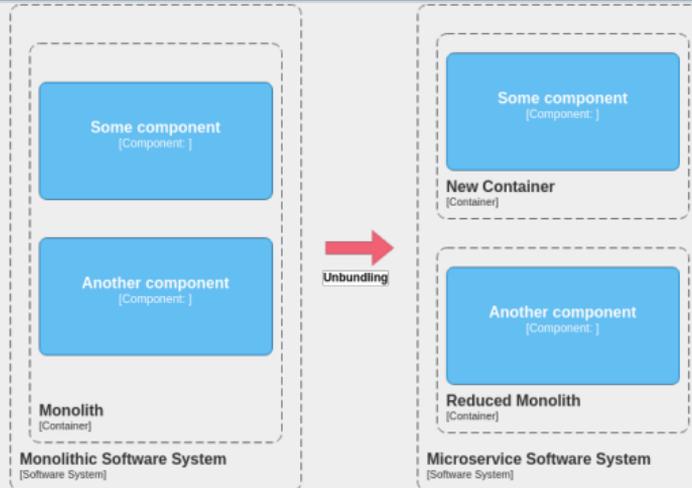
- Multiple processes
- Separate containers possible

Unbundling: Identify business functionalities (Bertolino et al. 2009; De Lauretis 2019)

JÜLICH
Forschungszentrum