RAVE
RESEARCH AT ALPHA VENTUS
Eine Forschungsinitiative des Bundesumweltministeriums

Data Warehousing for Distributed R&D Overview and Insights gained

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Projektträger

Koordination

Bundesministerium
für Umwelt, Naturschutz
und Reaktorsicherheit

Projektträger Jülich
Forschungszentrum Jülich

Fraunhofer
IWES

OFFIS
INSTITUT FÜR INFORMATIK

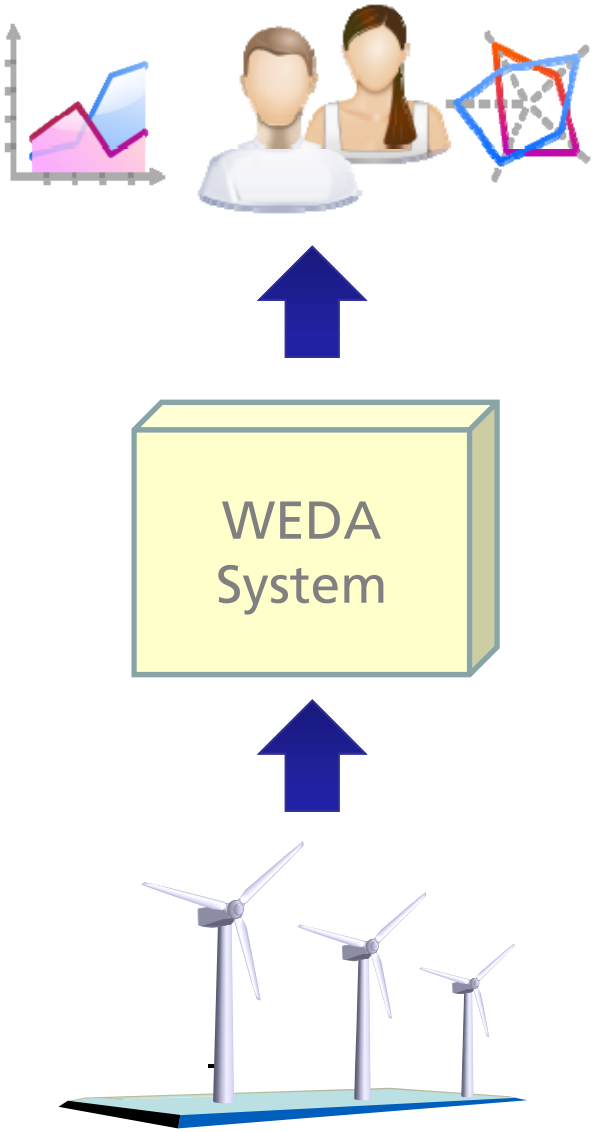
R&D Institute for ICT

- Associated institute of the Carl von Ossietzky University in Oldenburg
- More than 290 employees (~150 research assistants)
- Established in 1991

R&D Divisions

Project Overview	Data Warehouse	Use in Transition	Current Measures	Insights Gained
0	1	2	3	4

Project Overview



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Data Warehouse (DWH)

- Collection and harmonization of engergy data
- Data provisioning for research accompanying the alpha ventus offshore wind park
  - Wind turbine (WEA) optimization
  - Environmental impact analysis
- Data access policy enforcement

Storage-Relevant Energy Data

- Secondary data (calibrated sensor data)
- Tertiary data (statistically aggregated data)
- Metadata (data on sensors and tertiary data)

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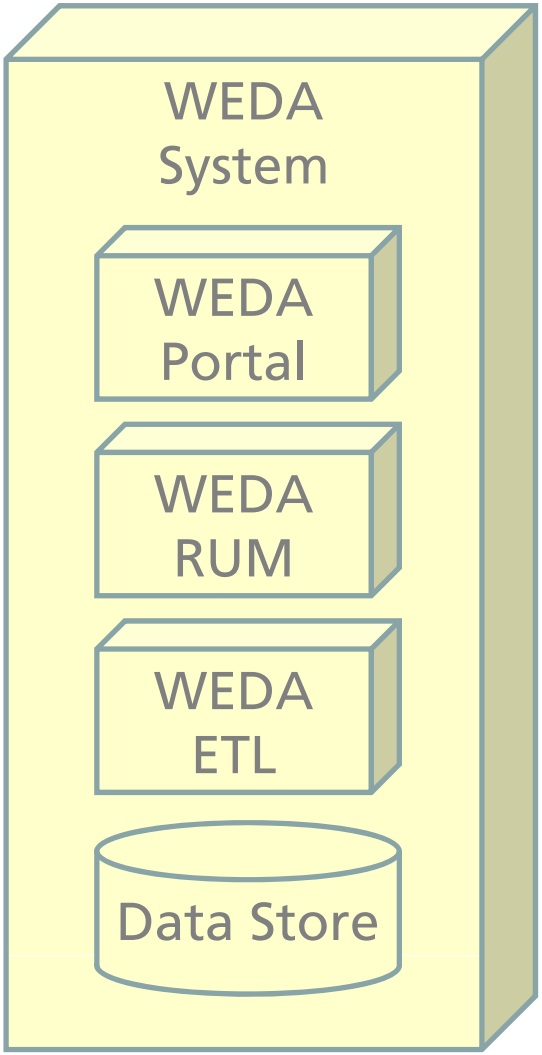
Architecture Overview



WEDA ETL

- Central component for sensor data storage and retrieval
- Monitors data input delivery and quality
- Guarantees technical data integrity

WEDA RUM

- Role-based user access control

WEDA Portal

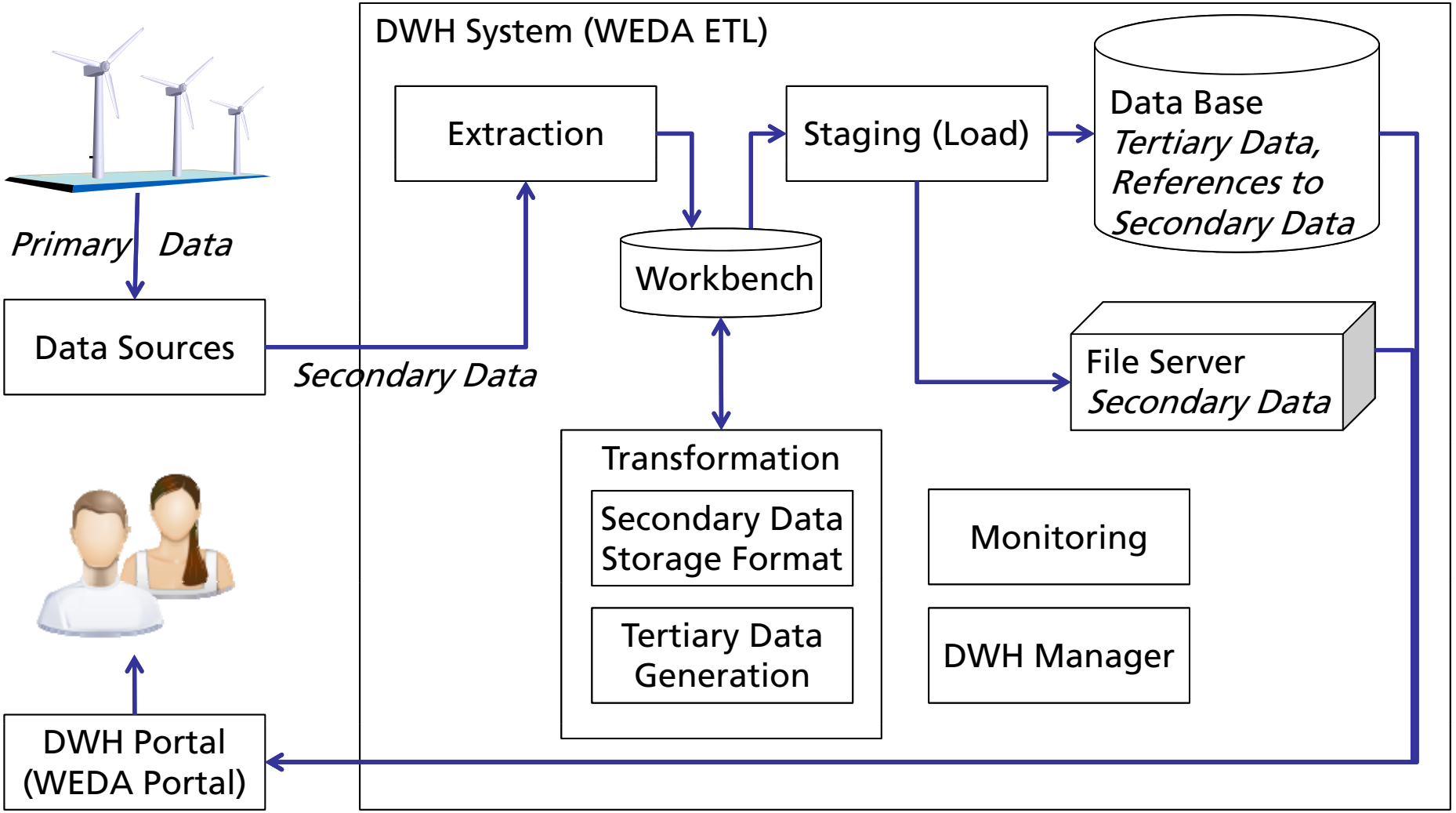
- Access portal for research partners
- Data exploration and download

Import Data Volumes

Survey „Storage Strategies for Sensor Data in Wind Energy“	alpha ventus DWH	Other (non-wind energy) Projects
20 to 250 sensors	1,500 sensors	*Data sizes comparable or even greater than those in alpha ventus*
5 min to 20 Hz	approx. 75% of the sensors operating at 50 Hz	
45,000 to 100,000 metered values per day	4,860,000,000 metered values per day	
	~18 GByte per day (data value size approx. 4 Byte) and 6.6 TByte per year	
Up to 45,000 values file system-based storage or data base; over 45,000 only file system-based storage	Hybrid (see next slide)	KIWI-concepts (*Kill it with Iron*) e.g., [Yuen et al., 2007; Ghemawat et al., 2003]
Volume reduction by compression	Volume reduction by compression	

Evaluation of Storage Strategies and Design choices for alpha ventus documented in [Beenken et al., 2009]

Hybrid Storage Concept



Extended DWH Reference Model in accordance with [Bauer and Günzel, 2004]

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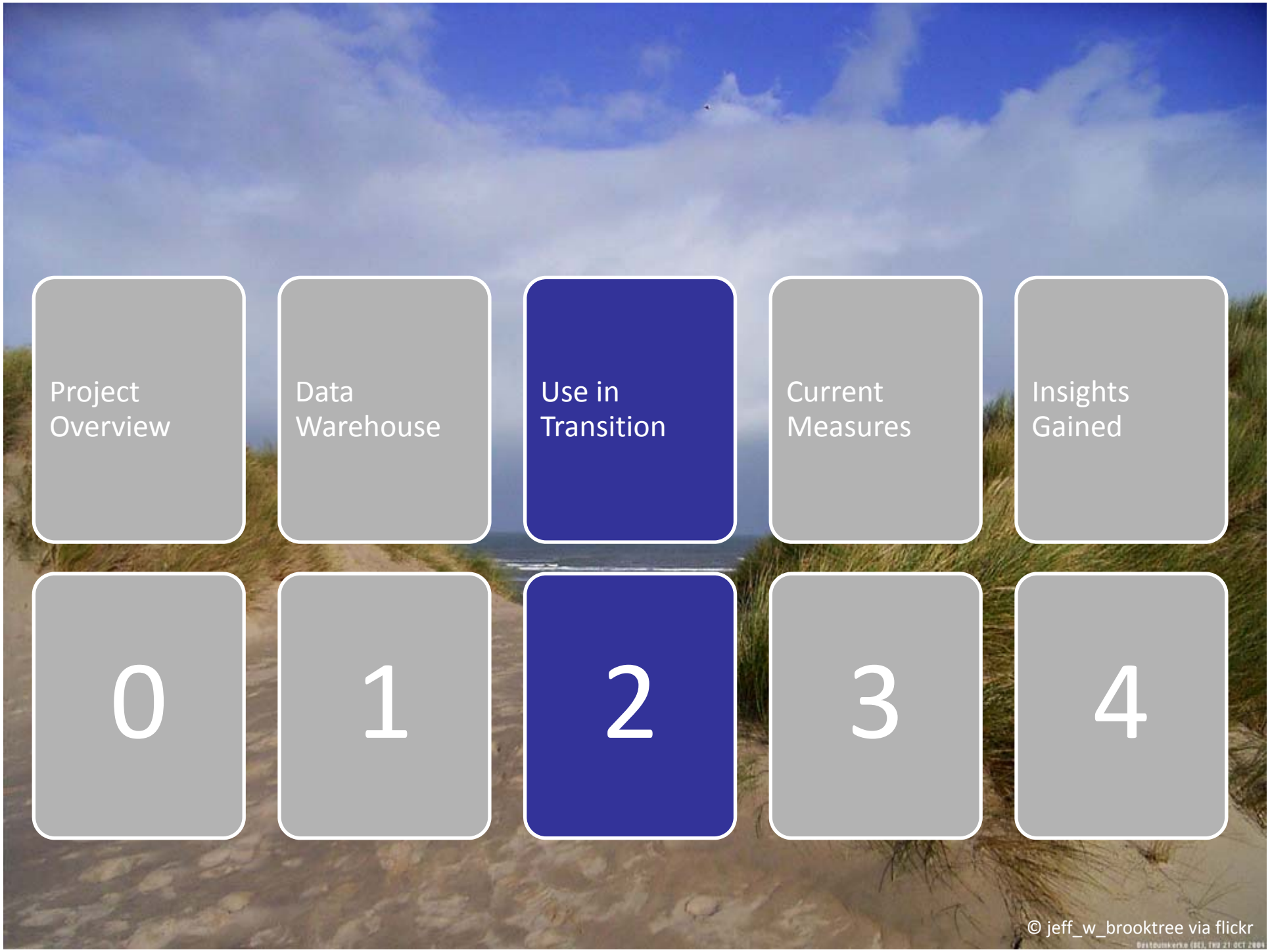
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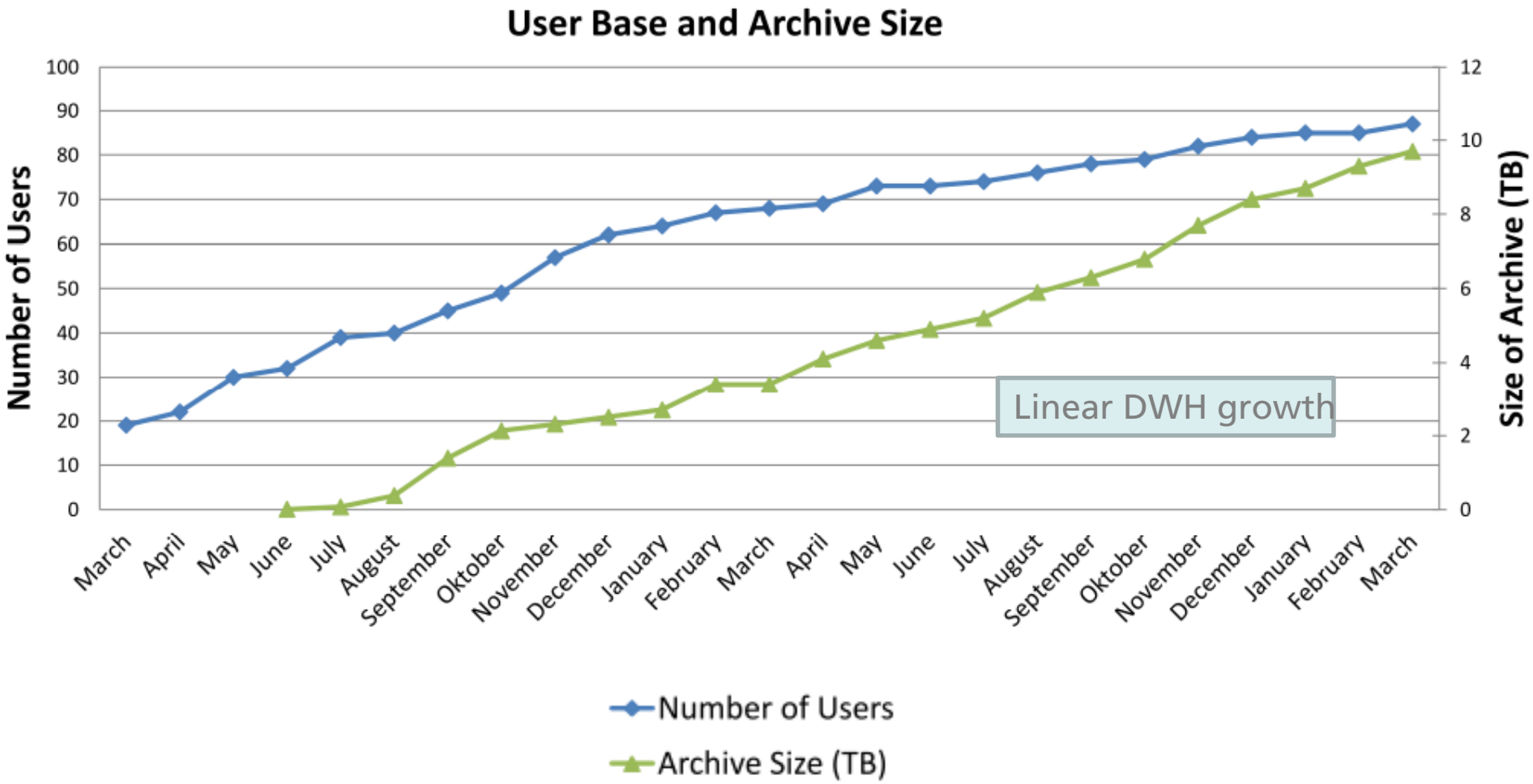

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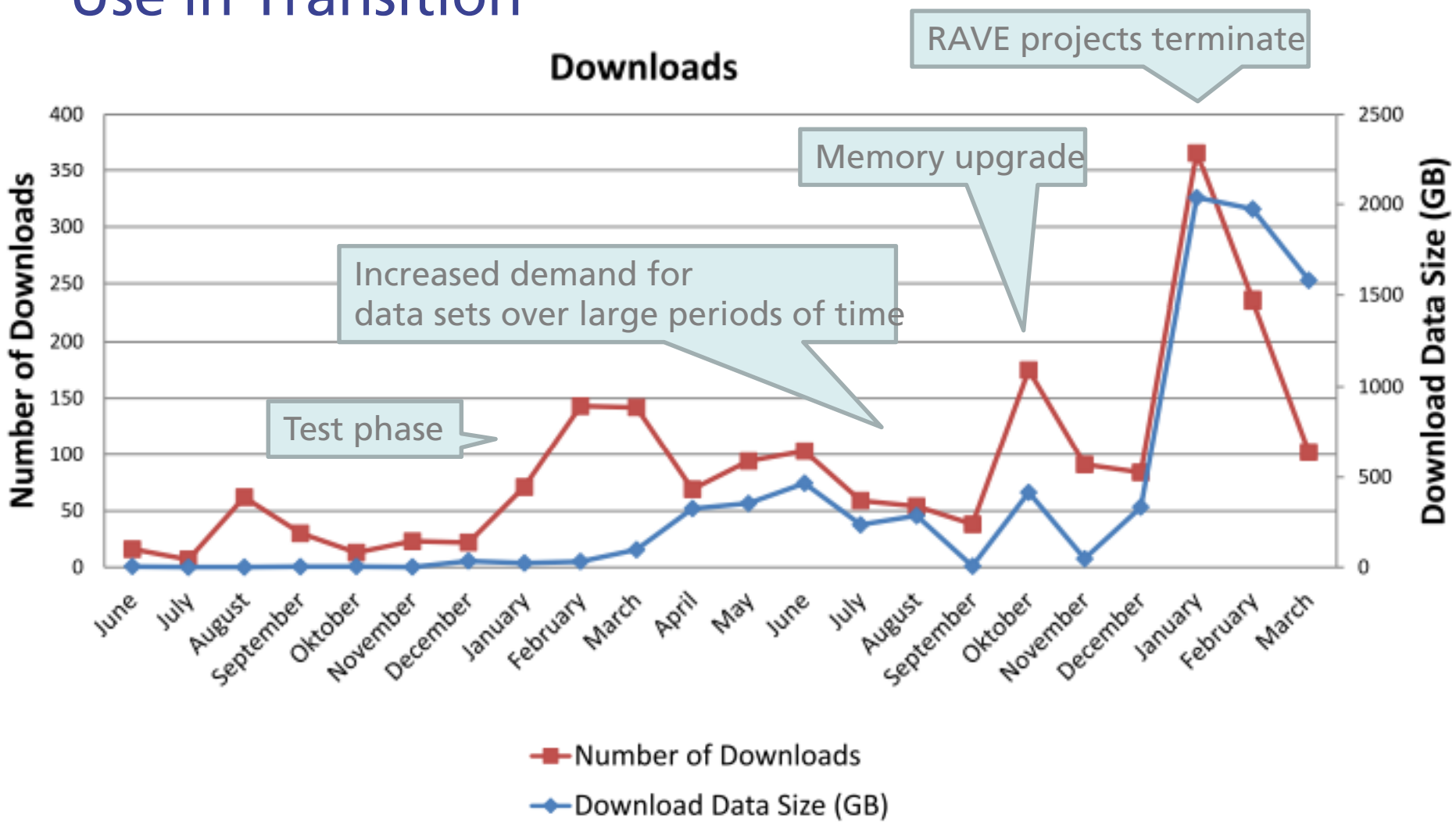

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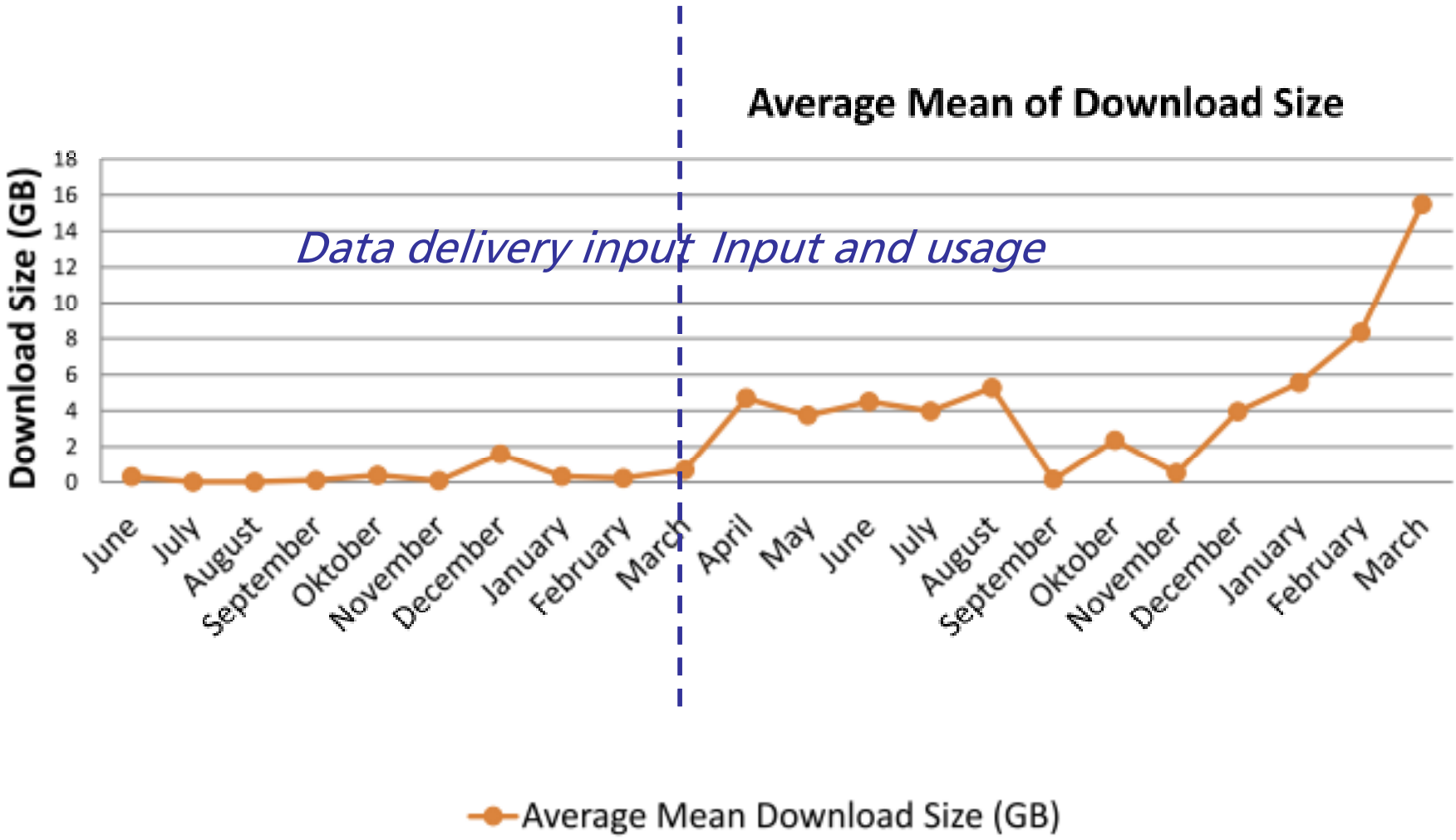

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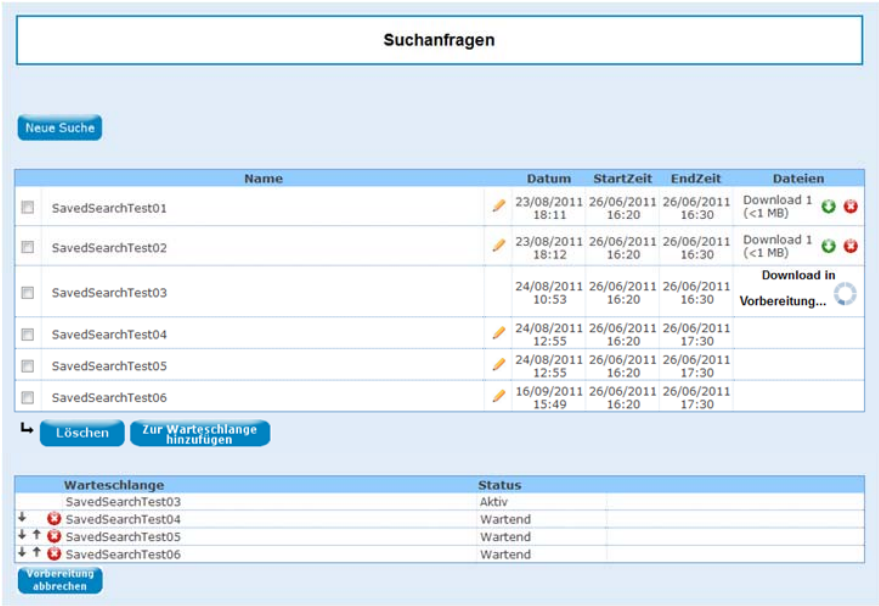
Current Measures

- Download cancellation and wait queue
- Complementary research documents
  - No restriction on file format
  - Upload is curated by OFFIS
- Time stamp calculation for download compilation
  - The frequency of the sensors could not always be met during data recording before delivery to DWH
- Data compression for volume reduction
  - Only data that is older than 1 year
  - On-the-fly decompression upon user queries
  - ~ 20% compression rate



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Insights Gained

Continuous Adaptations

- Query optimization and table index updates (cascading change effects)
- Changes to data format specification required changes to the portal and repeated downloads
- Increased demand for data sets over large periods of time required memory upgrade

Local DWH test instance

- Test with representative/real-life data after storage design phase

Tendency to local copies

- If data is available, researcher partners will also want them on their own systems

Insights Gained

Recurring technical data quality issues

- Delivered secondary input data to be stored in the DWH did not always conform to the agreed specification
- Communication overhead

Domain-specific data quality and additional information

- If delivered secondary input data is corrupted, it probably can be resolved automatically by batch processing
  - Batch job can be considered as a part of the sensor → must also be documented and archived
  - Unclear if processed data should replace the corrupted data or if it should be stored separately
  - In general, experimental documentation and data history is highly relevant for future research projects

Outlook

- Progress information for big download compilations
- Thorough use of multithreading
  - e.g., for uploads and download compilation
- Development of a performance laboratory based on the local DWH test instance
- Re-evaluation of DWH-internal storage structures
- Server-side data processing and analysis
  - e.g., standard interfaces for aggregated statistical data

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[Bauer and Günzel, 2004] Bauer, A.; Günzel, H.: *Data Warehouse Systeme*, dpunkt-Verlag, 2004

[Beenken et al., 2009] Beenken, P.; Schwassmann, S.; Albrecht, M.; Appelrath, H.-J.; Heisecke, S.: *Speicherstrategien für die Sensordaten des Offshore-Windparks alpha ventus*. Datenbank Spektrum, Heft 28, February 9, 2009

[Yuen et al., 2007] Yuen, C.; Hopkins Dreyer, L.; Krneta, P.: *Performance Sizing Report – Petabyte Data Warehouse*. InfoSizing, Inc., August 20, 2007

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Hybrid Storage Concept

Storage Efficiency

- Secondary data stored in file system
- Tertiary data calculated from secondary data and stored in data base
- Tertiary data references the corresponding secondary data in the file system

Data Handling

- Users can analyse tertiary data before secondary data must be considered and downloaded

Export Optimization

- Secondary data can be downloaded directly
- Users can select subsets of secondary data (queries) according to various parameters; server-side recompilation provides only the relevant data

Long-Term Technology-Independent Storage

- Guaranteed by file system-based secondary data storage in plain CSV format

Import Data Volumes

Some numbers

- 1,500 sensors, approx. 75 % operating in 50 Hz
- 4,320,000 data values per day and 50 Hz sensor
- 4,860,000,000 data values per day