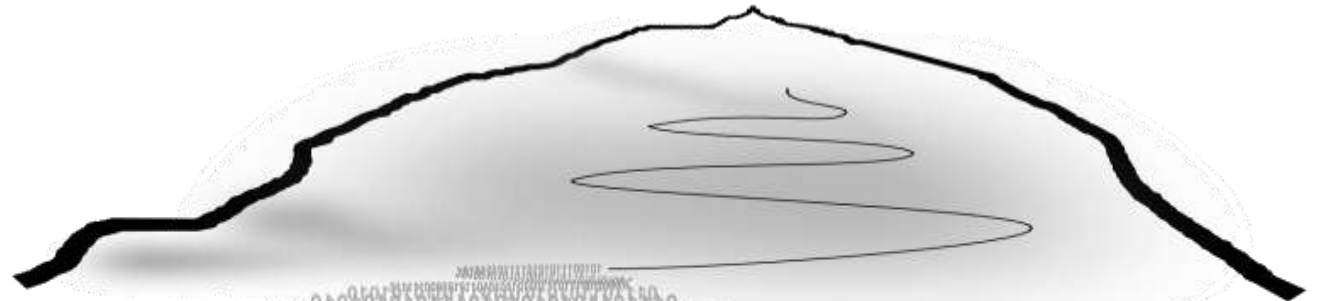


Die Large Scale Data Facility des KIT

Rainer Stotzka, Jos van Wezel

Institute for Data Processing and Electronics

In close collaboration with:
Steinbuch Centre for Computing
Institute of Toxicology and Genetics
Institute for Applied Computer Science



01110110101010101110101010

Wissenschaftliche Experimente erzeugen Daten

USCT
zur Brustkrebsdiagnose



0,3 **PetaByte**
pro Jahr

ANKA
Synchrotron-
Strahlenquelle



1 **PetaByte**
pro Jahr

Robotische **Mikroskopie**
in der Biologie



1 **PetaByte**
pro Jahr

... und viele andere mehr ...
(FAIR, X-FEL, ITER, KATRIN, ...)

? **PetaByte**
pro Jahr

**WOHIN,
WIE
???**

Programm Supercomputing

Die **Large Scale Data Facility** ist eine Einrichtung des KIT in der HGF mit dem Ziel, das bedeutendste Zentrum zur Speicherung und Analyse von Experimentdaten in Europa zu werden.

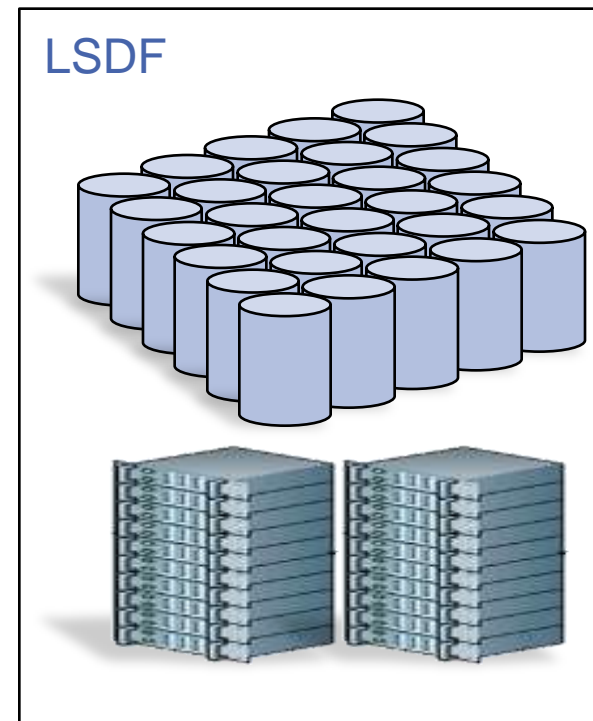
■ 6 PetaByte →

■ 58 Knoten mit je →

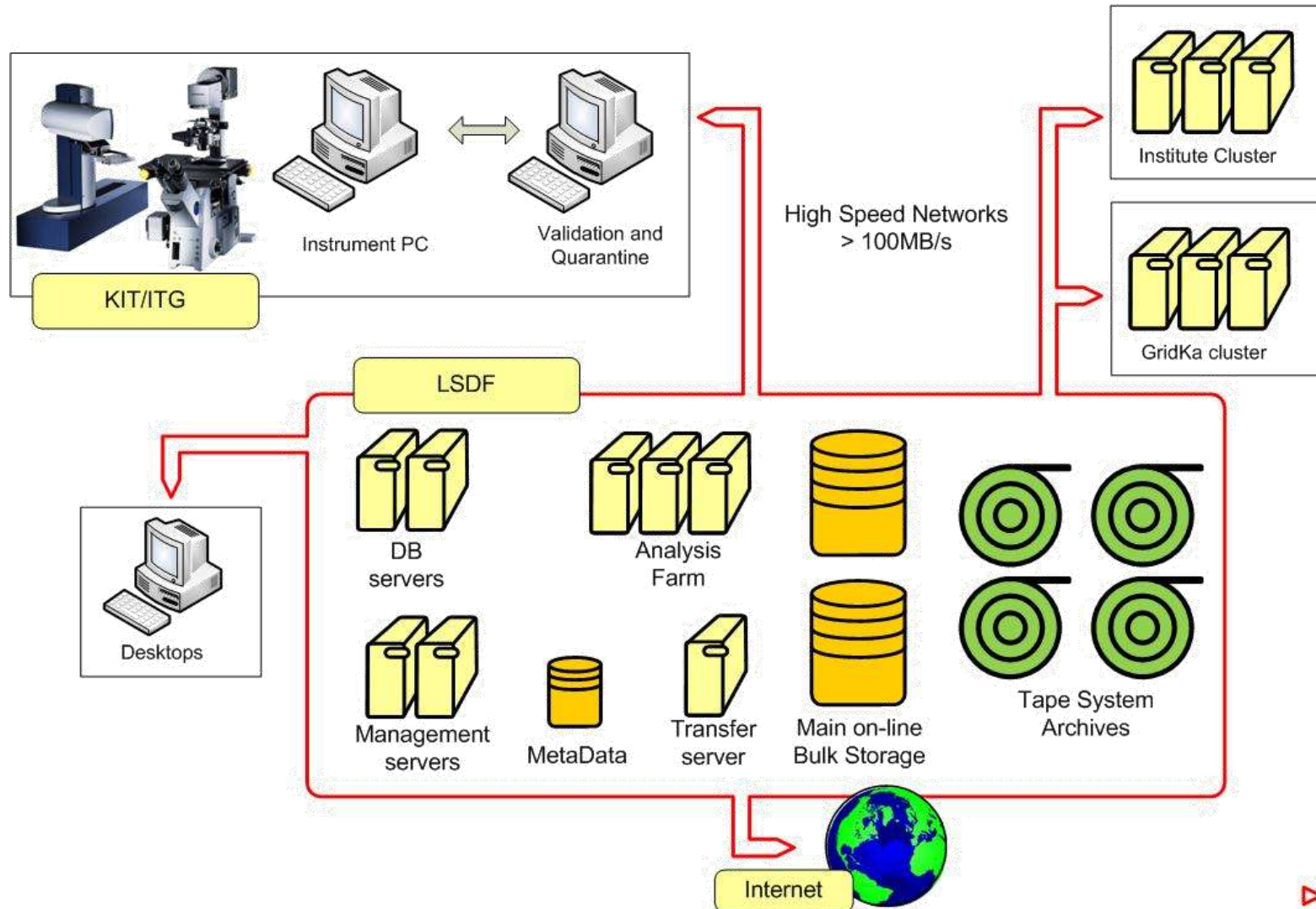
- 8 Prozessor-Kernen
- 36 GigaByte Speicher
- 1 TeraByte Festplatte

■ 10 GigaBit/s Netzwerke →

(Stand 2010)



Internal structure



LSDF objectives (from the user's point of view)

■ Objectives:

Storage

- Dedicated for science data
- ExaByte scale data
- To archive data, long term sustainability (10 yrs. – ?)

Interactivity

- To enable scientists to gain better scientific results by providing
 - Data intensive analysis
 - Added value services for data intensive processing
- To provide high performance access, high throughput
- “Barrier free” access (easy-to-use)



■ Conflicting objectives:

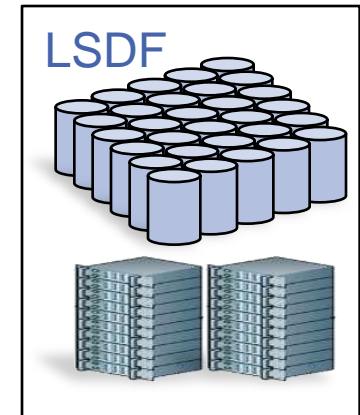
- Archive – high throughput
- Enhanced functionality – simplicity

The LSDF strikes a new path

- Scientists dream: as simple as a USB hard disk

LSDF is more complex:

- ExaByte scale
- Distributed composite of various technologies:
hard disks, IBM-systems, networks, Hadoop, ...
→ internal dynamics caused by replacing or adding
new components: disks, archives, techs, etc.
→ sea of data with internal flow
- Added value services,
e.g. automatic processing of new data
→ additional information
- Security: worldwide access



Why is meta data necessary?

Meta data describe the contents of data

- Everybody uses meta data:
 - File name and extension
(e.g. `rainer.jpg`, `budget.xls`, `Readme.doc`)
 - Location
(e.g. `/.../EU-projects/2010/Fishy/budget.xls`)
 - Personal know-how

→ Sufficient for small file systems

Have you ever tried to locate a file or info-somewhere-in-a-file-system

- 15 years old ?
- in the file system of a colleague ?
- in a 100 PetaByte file system ?

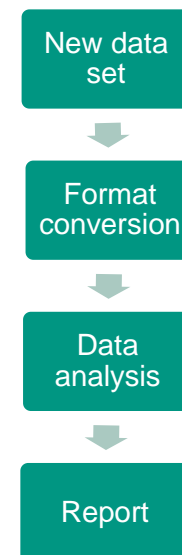
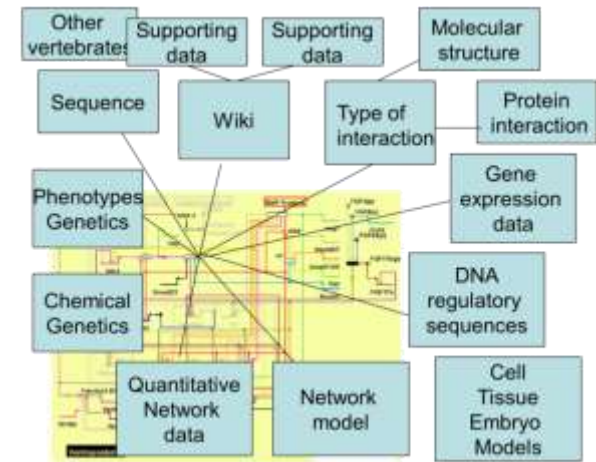
PANIC ?

Applications requiring meta data

- Data archiving and retrieval (libraries)
- Fusion of complex data from various sources (data integration)

Community-specific services:

- Automatic processing (e.g. automatic analysis starts when data appears)
- Analysis chains (reporting analysis workflow, results and errors)
- Google and Yacy
- Etc.

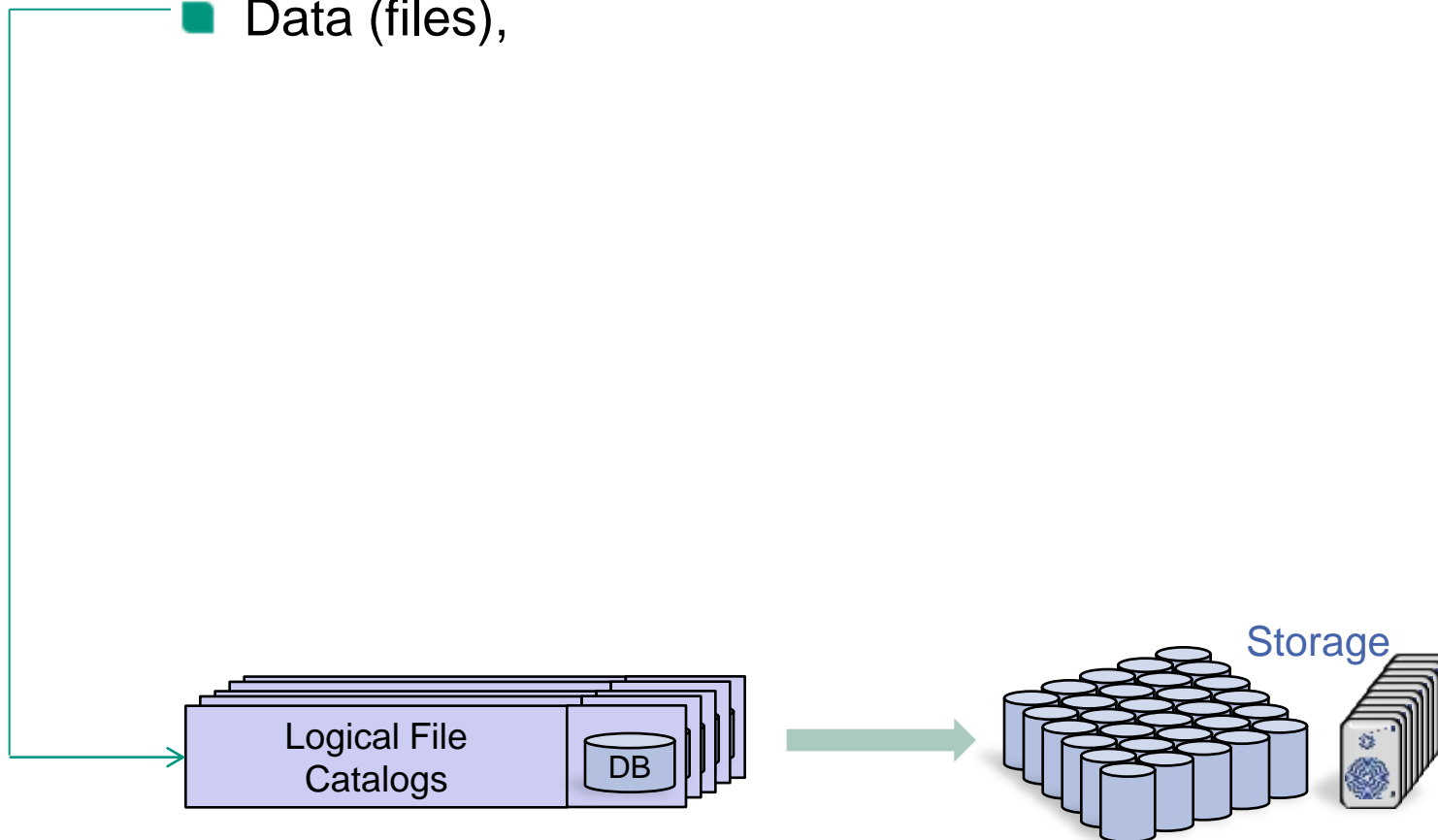


Model of the LSDF meta data management

Idea:

Clear separation between

- Data (files),

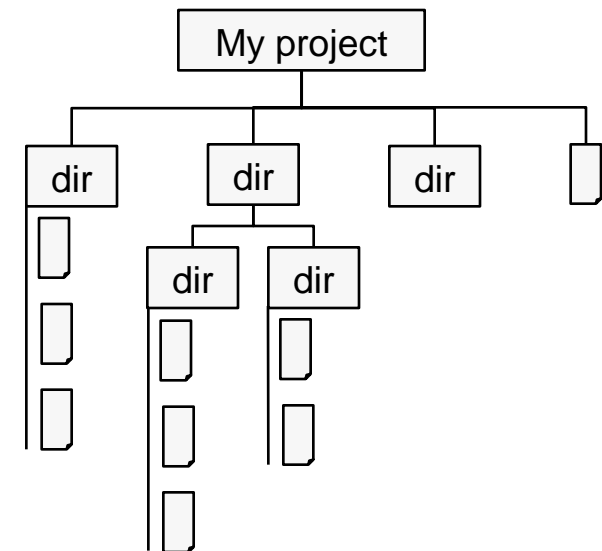
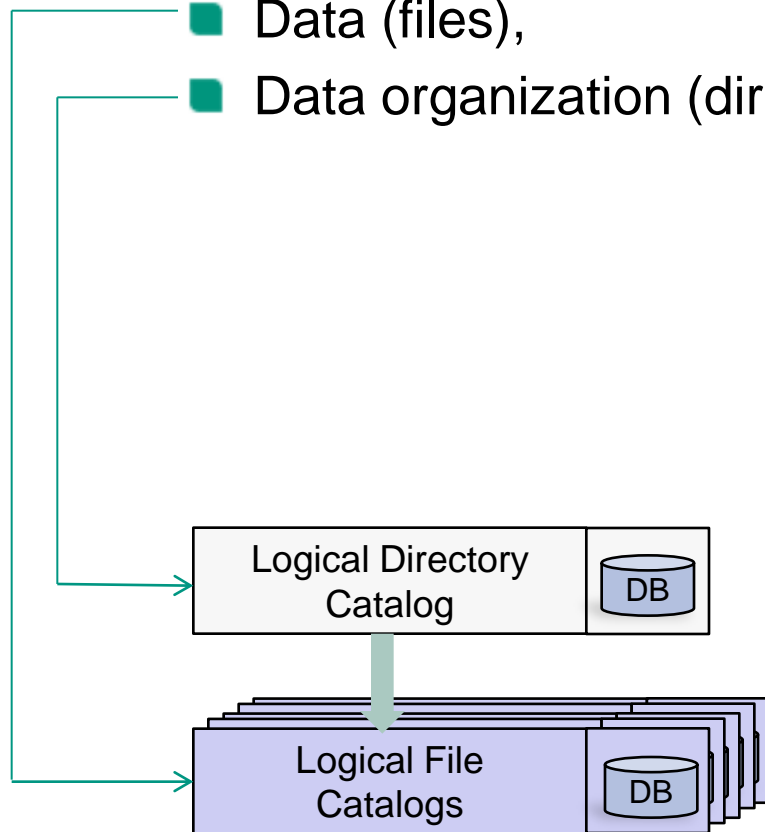


Model of the LSDF meta data management

Idea:

Clear separation between

- Data (files),
- Data organization (directory structure)

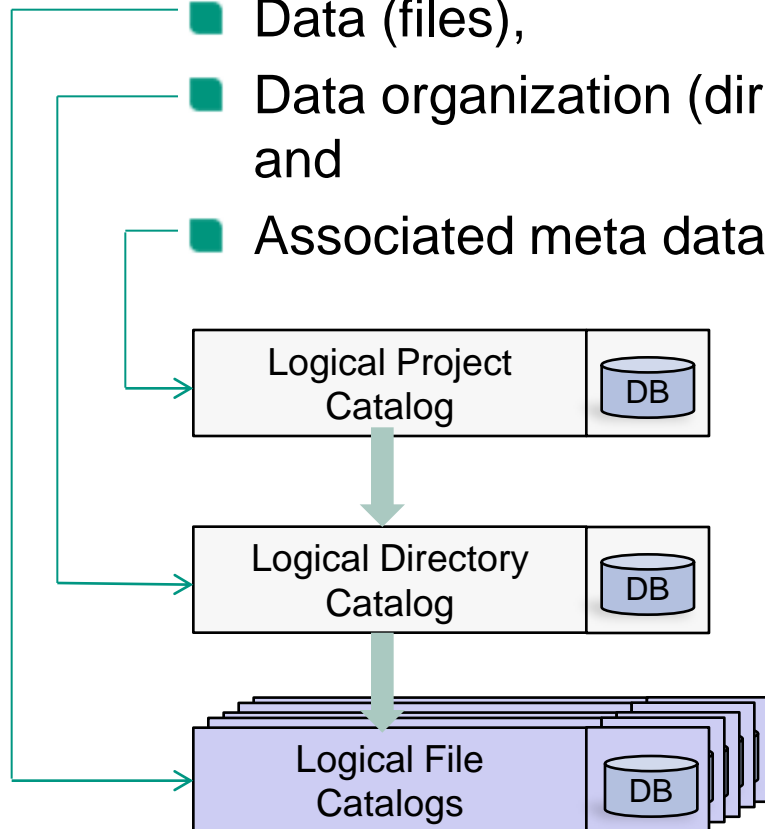


Model of the LSDF meta data management

Idea:

Clear separation between

- Data (files),
- Data organization (directory structure) and
- Associated meta data

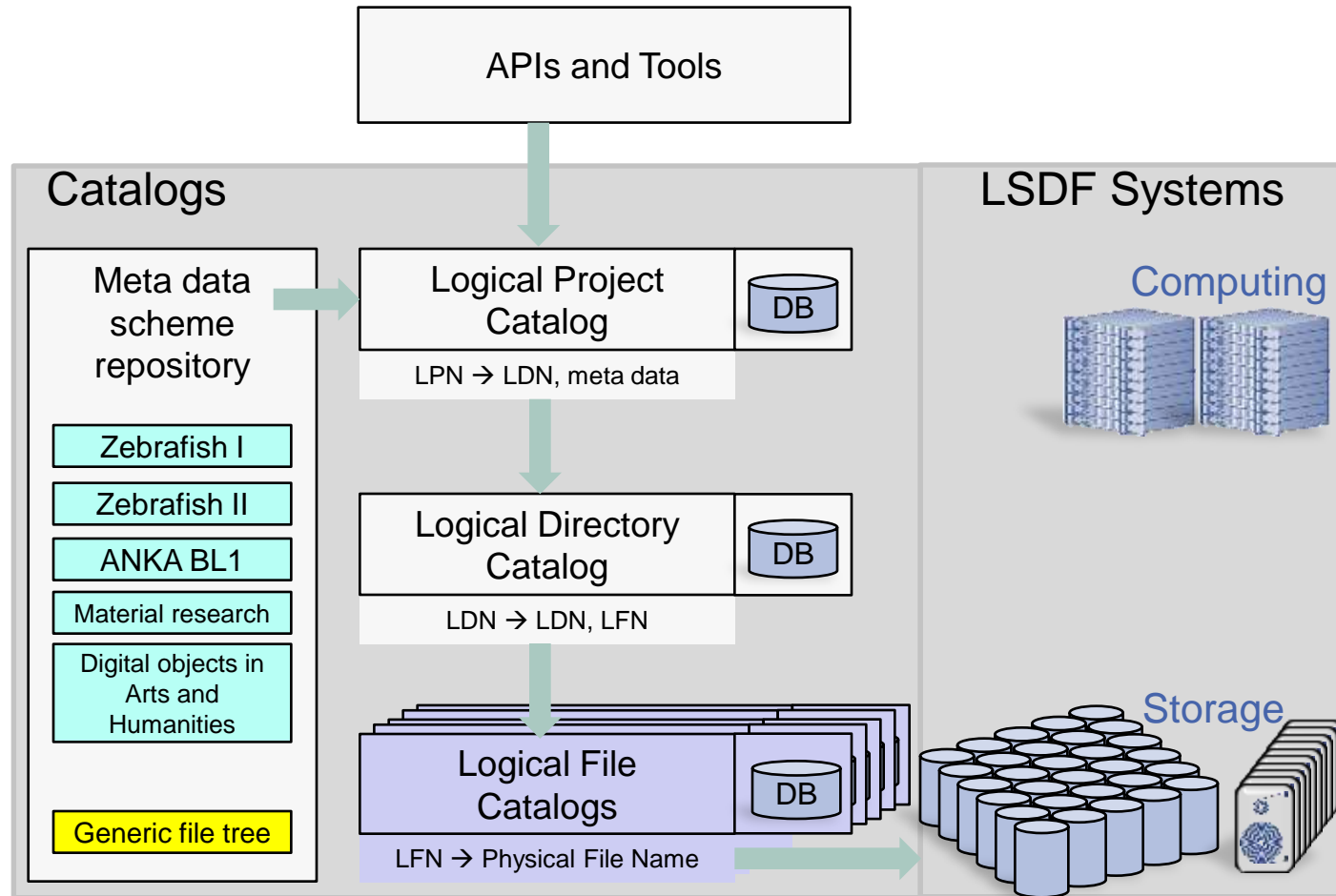


- name
- owners
- access rights
- date
 - community
 - (sub)subcommunity
 - measurement type
 - device, instrument
 - ...

Meta data structure depends on project, instruments, **time**, ...

Hierarchical Catalog System

- Sustainable
- Easily extensible
- Independent of data formats
- Enhanced performance: distribution of access
- Safety by redundancy
- Easy-to-use?

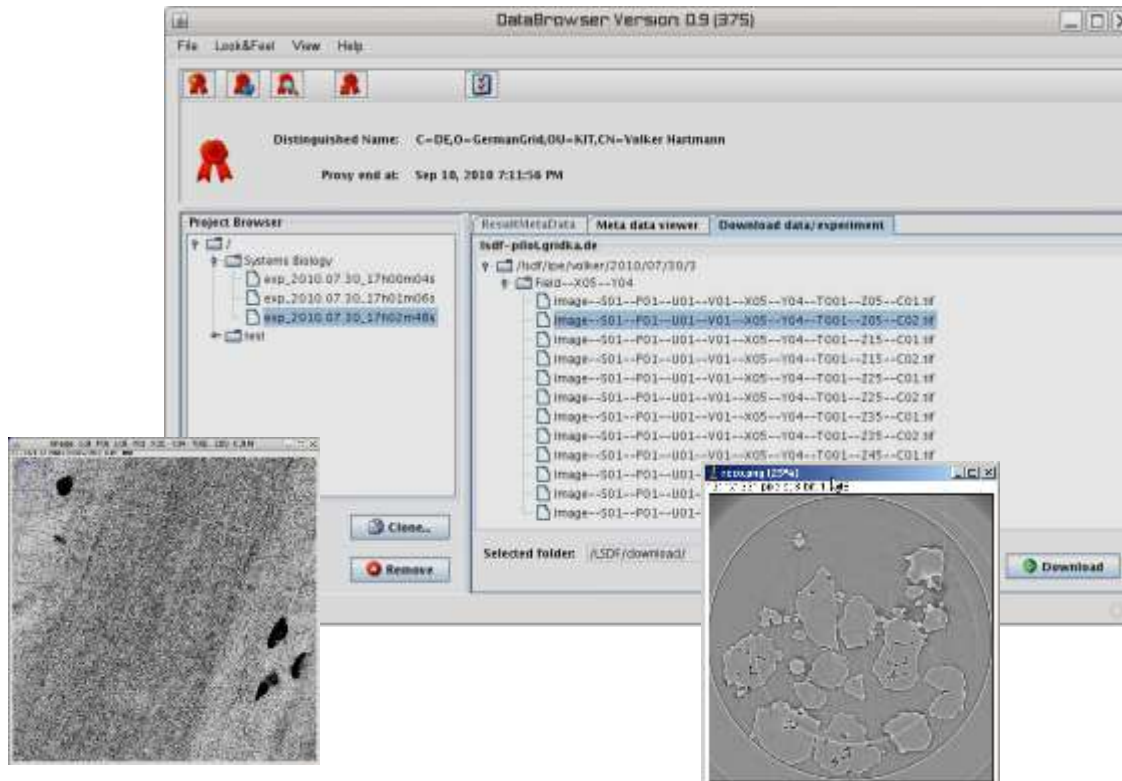


How to handle the complexity?

- *Apparently more complex: how do I use it?*

- Simple access tools, which can be easily adapted to your specific needs

- **Data Browser** is a File-, Data- and Project-Explorer



Data Browser allows:

- Authentication
- Project and file browsing
- Upload
- Download
- Edit meta data
- Data visualization
- Control data analysis

Features:

- Extensible
- Huge variety of communication protocols
- Open source

How to handle the complexity?

- *How do I insert a new scientific project ?*
 - Data and meta data organization experts for projects with specific needs
 - Generic meta data format for simple file trees

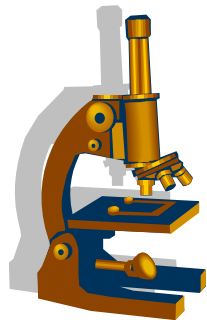


- *How do I transfer my data to a different location?
Do I lose my meta data?*
 - Import-export to standard data and meta data formats
 - Archive-in-a-box
(Web installer or DVD, zip-archive, etc.)



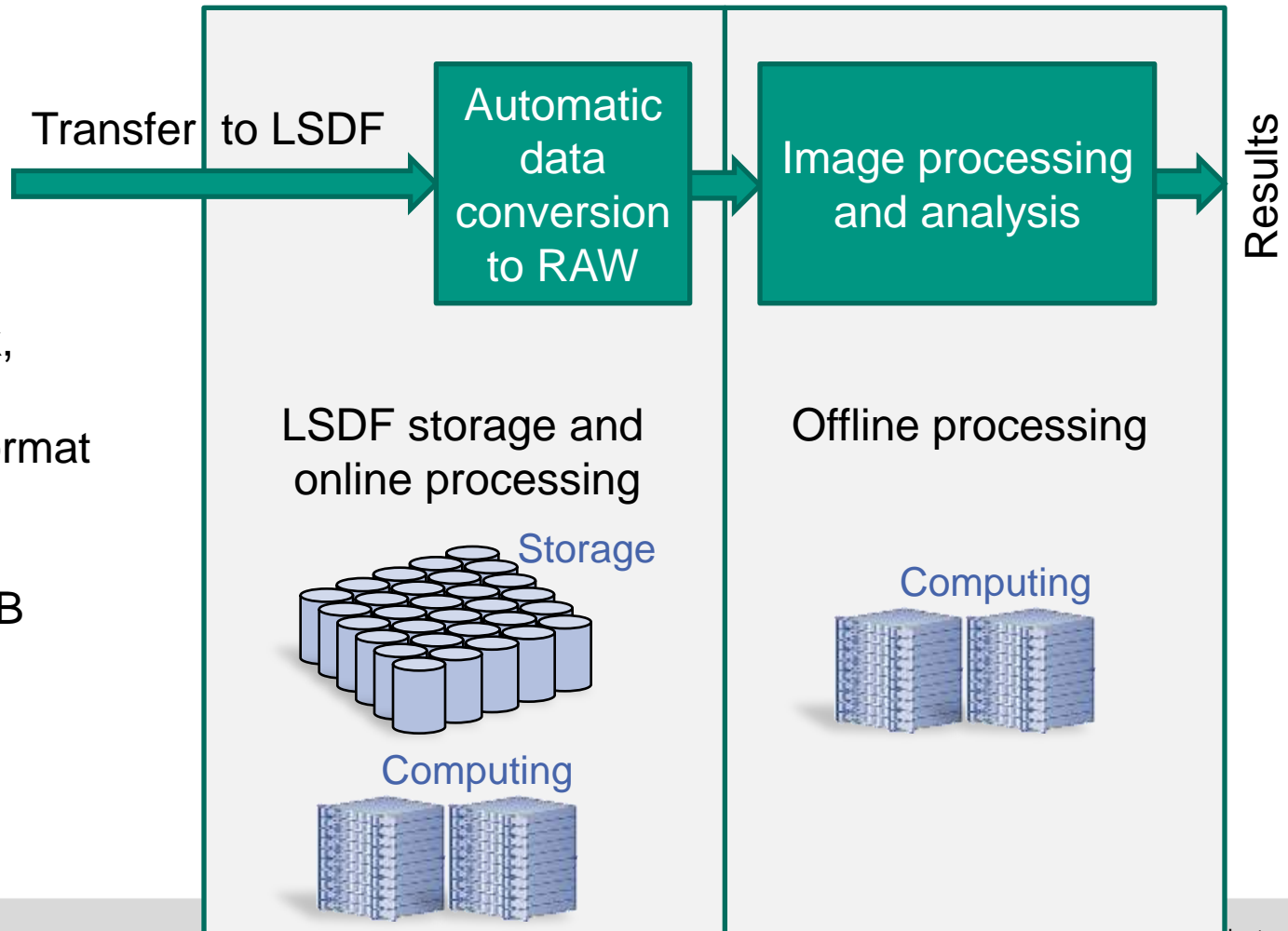
Example: ITG Vertebrate Development

- Complex image analysis chain:



3D image stack,
time series,
Leica Image Format

data set size:
100 GB



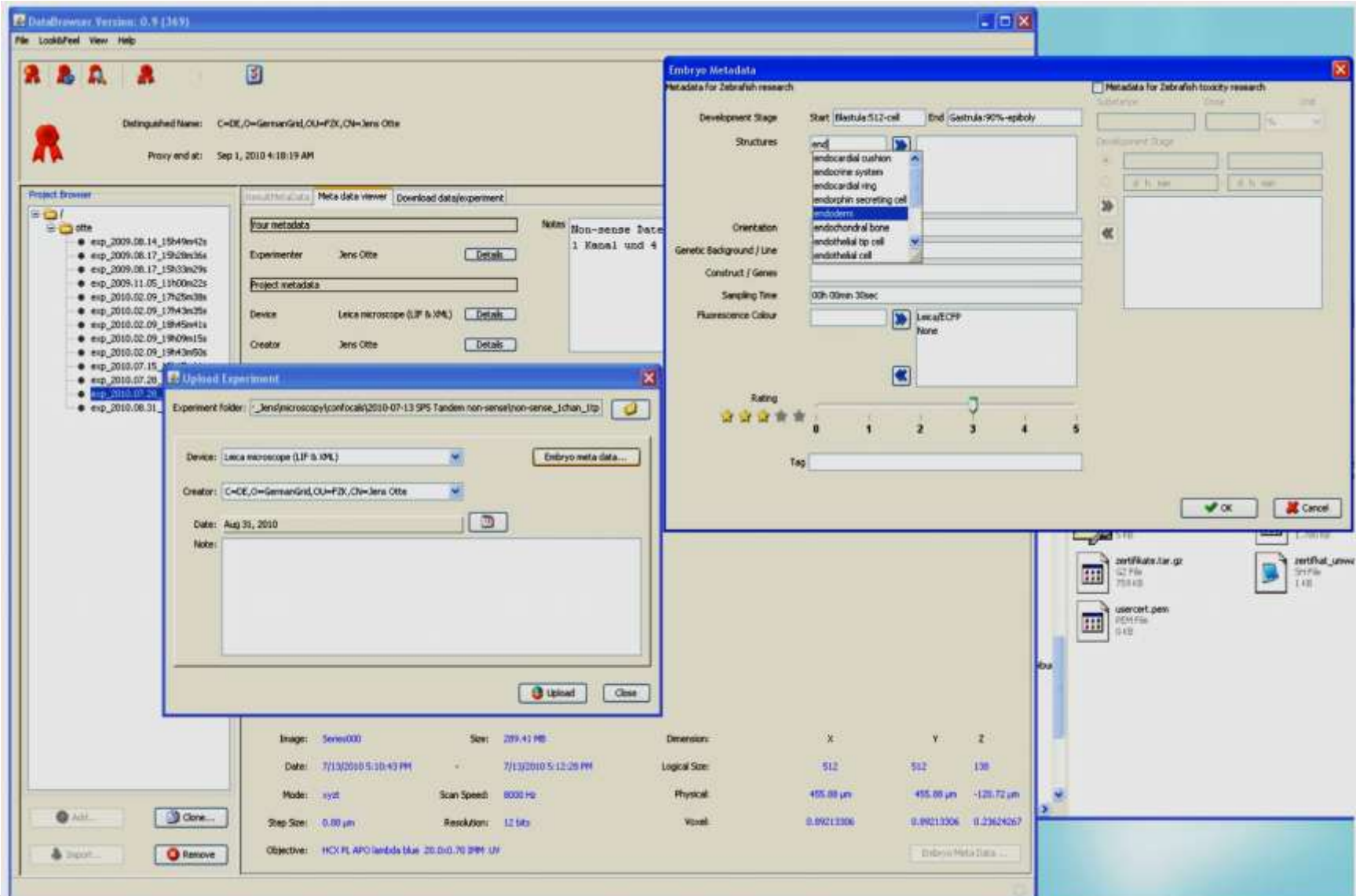
Example: ITG Vertebrate Development

- Close cooperation ITG, IAI, SCC and IPE
(Thanks to Jens C. Otte for the images)

Data Browser:

- Meta data organization
- Adapted Data Browser implementation
- Automatic data conversion workflow at LSDF steered by meta data

Example: ITG adapted DataBrowser



The screenshot displays the DataBrowser software interface, version 0.9 (369). The main window is titled "DataBrowser" and contains several panes and dialog boxes.

Main Window:

- Project Browser:** Lists experiments with identifiers like "exp_2009.06.14_19h49m12s".
- Metadata Viewers:** Includes "Experiment metadata" (Experimenter: Jens Otte), "Project metadata" (Device: Leica microscope (LIF & ILM)), and "Creator" (Jens Otte).
- Notes:** A text area containing "Non-sense Data" and "1 Kanal used 4".
- Image Information:**

Image:	Series000	Size:	209.41 MB	Dimensions:	X	Y	Z
Date:	7/13/2010 5:10:43 PM			Logical Size:	512	512	138
Mode:	xyzt	Scan Speed:	8000 Hz	Physical:	495.88 µm	495.88 µm	-129.72 µm
Step Size:	0.80 µm	Resolution:	12 bits	Visual:	0.89213306	0.89213306	0.23624267
Objective:	HCX PL APO lambda blue 20.0x0.70 2PM UV						

Embryo Metadata Dialog:

- Metadata for Zebrafish research:** Includes fields for Development Stage (Start: Blastula 512-cell, End: Gastrula 90%-epiboly), Structures (dropdown menu with options like endocardial cushion, endocrine system, etc.), Orientation, Genetic Background / Line, Construct / Genes, Sampling Time (00h 00min 30sec), and Fluorescence Colour (Leica/ECHO None).
- Rating:** A star rating system from 0 to 5.
- Tag:** A text input field.

Upload Experiment Dialog:

- Experiment folder:** _Jens/microscopy/confocal/2010-07-13 SPS Tandem non-sense/non-sense_1chan_tfp
- Device:** Leica microscope (LIF & ILM)
- Creator:** C=CE, O=GermanGrid, OU=FIK, CN=Jens Otte
- Date:** Aug 31, 2010
- Note:** A large text area for additional information.

File Explorer: Shows files like "certificate.tar.gz", "usercert.pem", and "certifkat_unwv".

Scientific communities

- Systems biology (ITG, BioQuant, Immunogenetics)
 - Vertebrate development studies and
 - Deconvolution
- Synchrotron facilities and beamlines
 - ANKA data storage
 - HGF “High Data Rate Initiative”
- Climate research
- Material research
- Arts and humanities



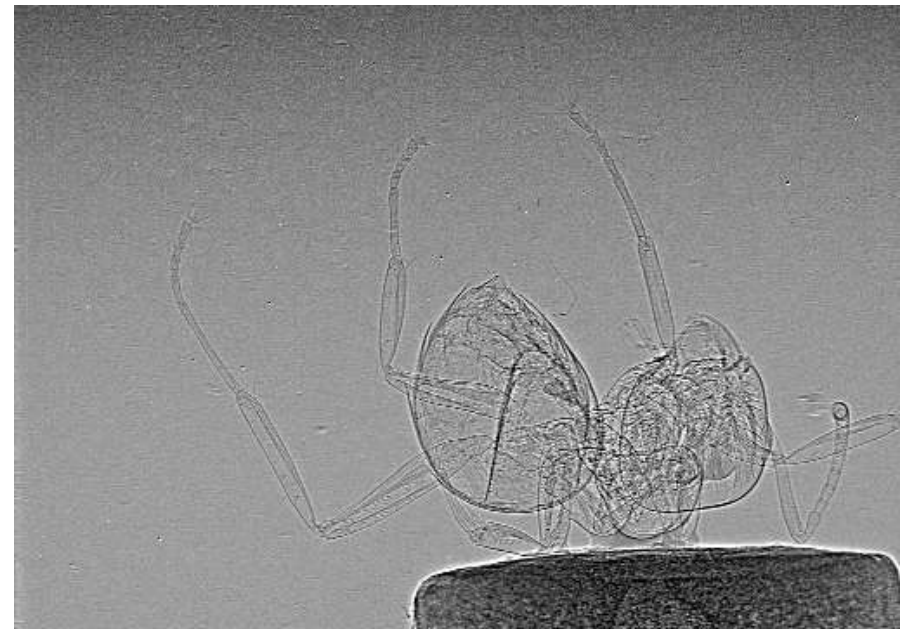
»Il Cenacolo« von Da Vinci (1494-98)



»L'ultima cena« von Julius Romanus (1754)

Data intensive science

- Remote instrumentation
 - Targeted at scientific instruments
 - Grid enabled e-infrastructure, distributed
 - Virtual control room
 - OGF RISGE-RG
- Algorithms for data analysis
- Visualization of huge 3D data sets:
online visualization of
500 GB data sets



Conclusions

- LSDF is a powerful structure
- Designed for future requirements

LSDF offers

- Sustainability
- Flexibility
- Interactivity
- Community-specific services
- Support



→ To gain faster and better scientific results