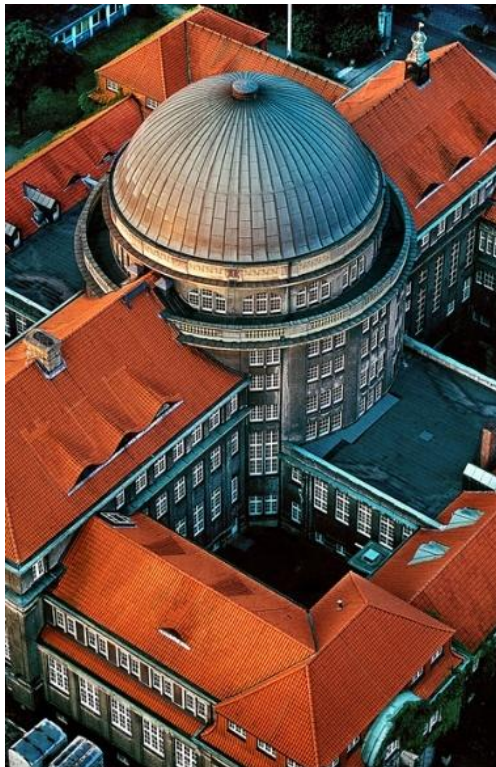




Universität Hamburg

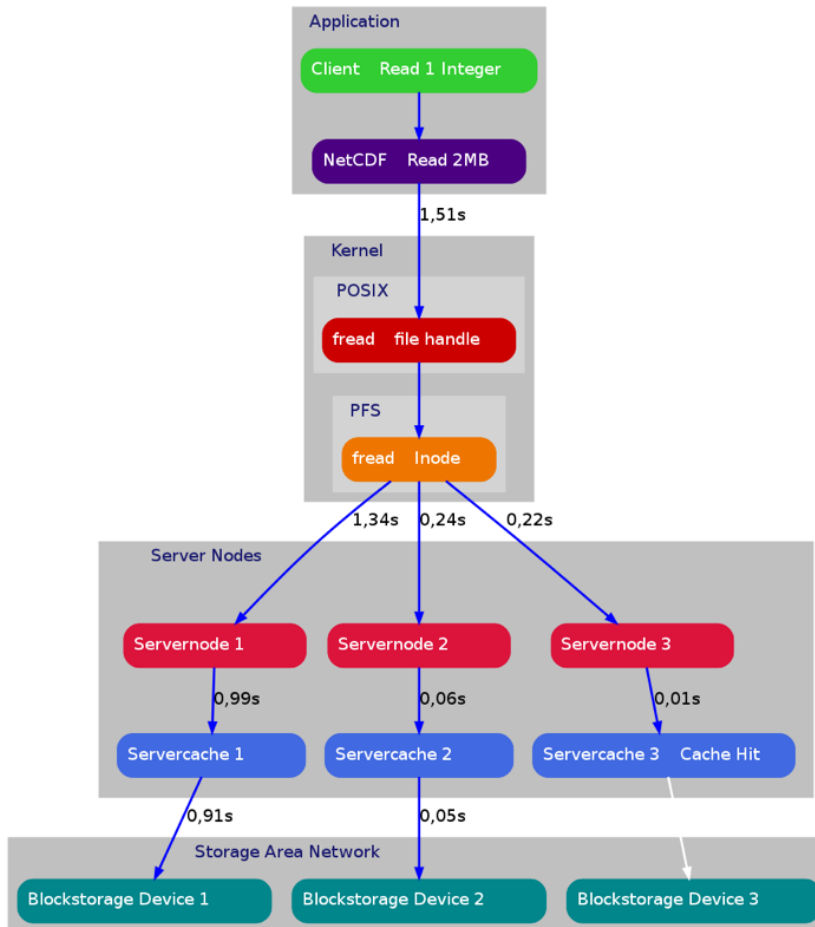
DER FORSCHUNG | DER LEHRE | DER BILDUNG



# Outline

- 1) Our Existing High-performance Application Problem
- 2) Intro to Project SIOX
- 3) Addressing Production HPC Systems
- 4) Examples of the SIOX Interface for Data Collection
- 5) Abstract Modeling Approach
- 6) Addressing Overhead: Intelligent Reduction of Data Volume
- 7) Conclusion

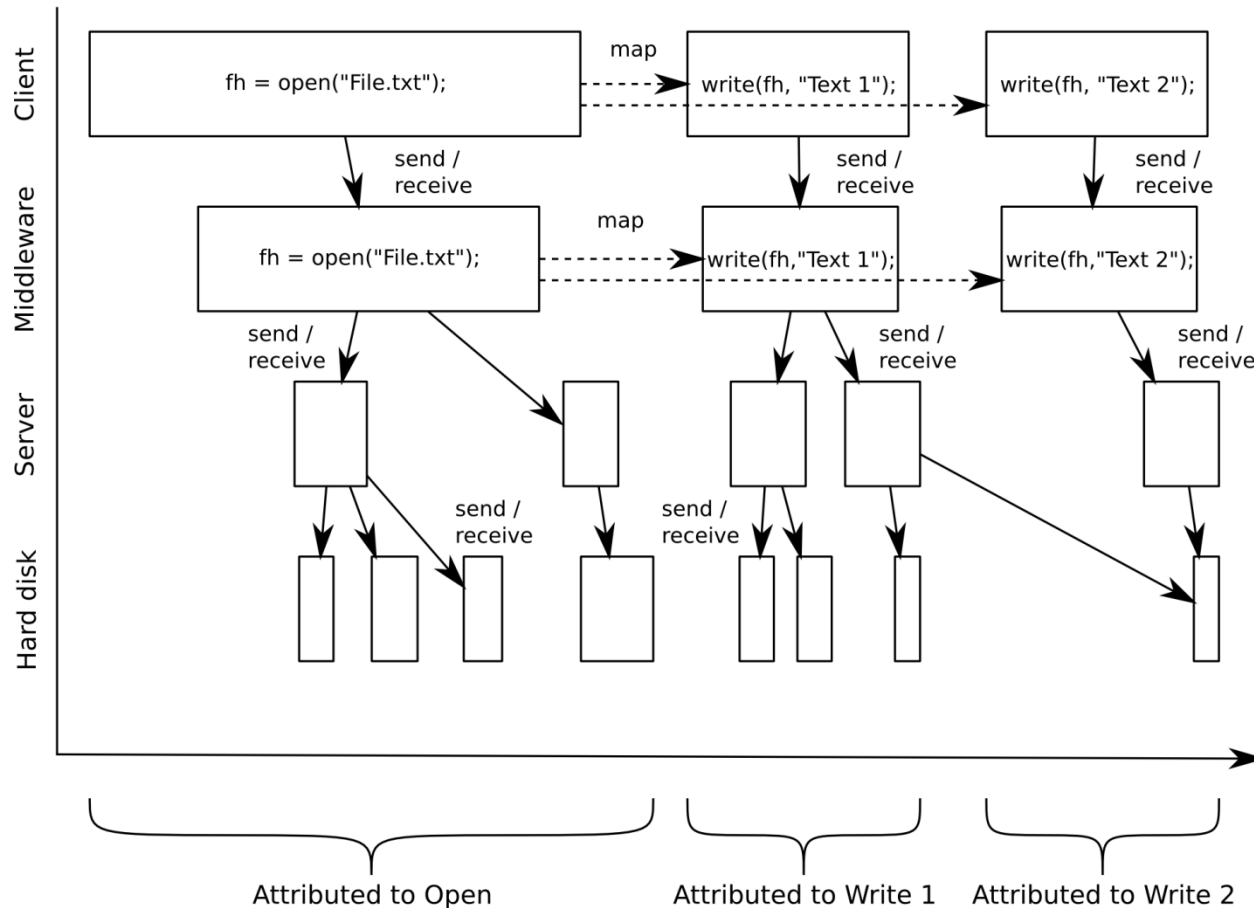
# 1 Motivation - Path of Data Access by Reading 1 Integer



- We will address all software and hardware layers and their interaction

# 1.1 Our existing Problem

## One Call to Cause Complex I/O



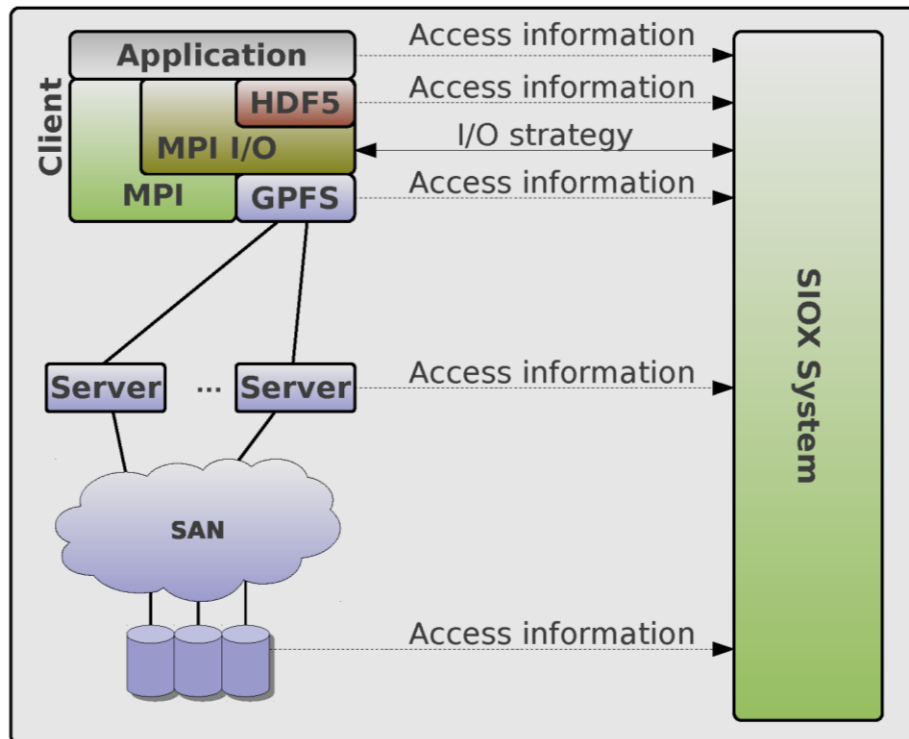
## 1.2 – Project Setup

- How can we address the shown complex behaviour?
- By
  - Collecting Access Information on All Layers
  - Information Aggregation
  - Proposing Optimizations

## 2 Scalable I/O for Extreme Performance



- 2.1 Project Layout



- The SIOX system measures Access-to-layer information
- The SIOX system implicitly recognizes causally related accesses along the I/O path
- SIOX proposes optimization parameters to MPI I/O middleware

## 2 Scalable I/O for Extreme Performance



- 2.2 Project Partners

- Universität Dresden  Zentrum für Informationsdienste und Hochleistungsrechnen
 
 Universität Stuttgart 
- Universität Hamburg  Universität Hamburg
 
 **DKRZ**  
 DEUTSCHES KLIMARECHENZENTRUM
 


- Funding by BMBF  Bundesministerium für Bildung und Forschung
 
 Project Agency 
- Runtime: 2011-2014 with a team of seven people

## 2.3 Key Objectives



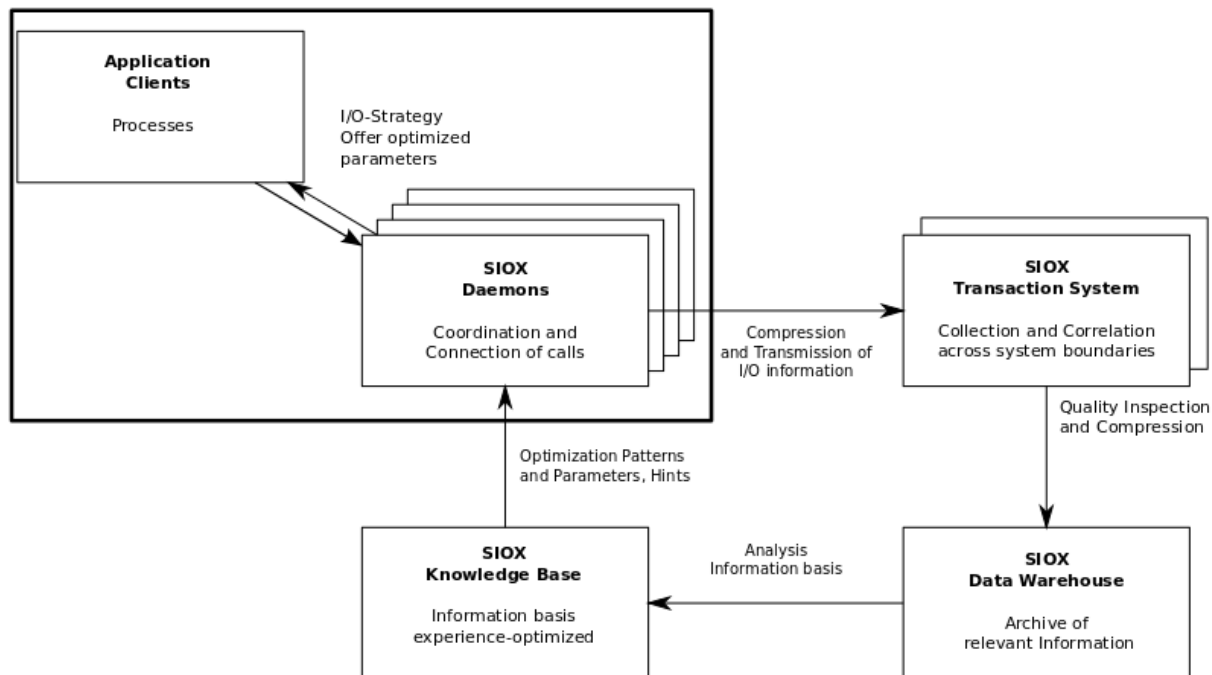
- Record Access Information on All Layers and Components.
- Recognition of Access Patterns.
- Characterization of the I/O system.
  
- Recognition of the Causes of the I/O bottlenecks.



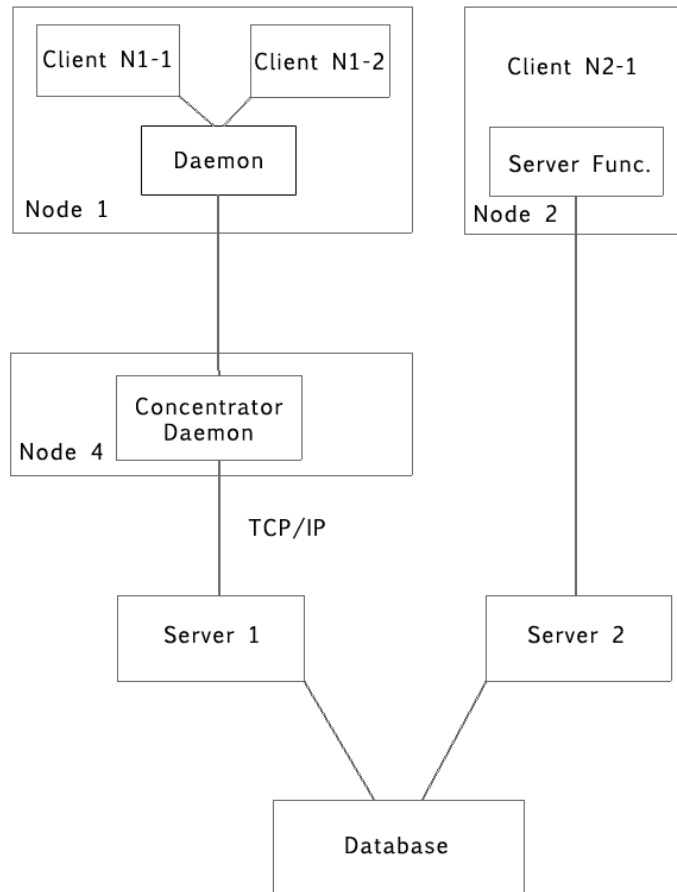
## 3 Addressing Production HPC Systems

- Optimization proposing for the I/O middleware to improve I/O performance, such as throughput rate and latency.
- As a bonus, the SIOX system will be able to support decision making while planning new I/O systems.

## 3.1 Global Architecture of an Iterative Learning Process

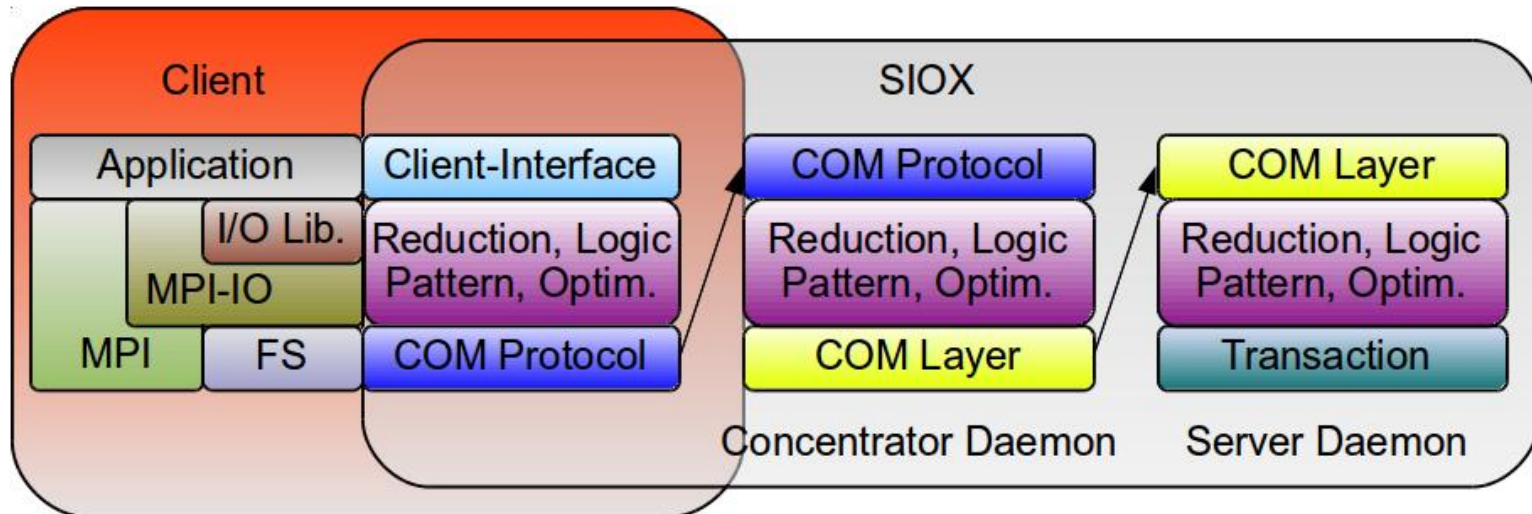


## 3.1.1 Receiving Access Info by Collecting and Aggregating Data



- Physical View
- A) Hierarchical Aggregation using many Collector(daemons) and fewer Concentrators.
- B) Direct Delivery to SIOX System (Server 2)
- SIOX Servers deliver information to SQL Database.

## 3.1.2 Modules for Communication and Transaction



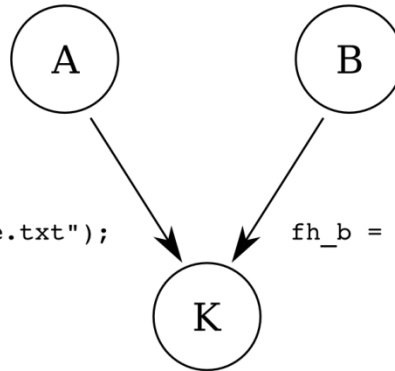
- Interface to the SIOX-system is the Client-Interface.
- Reuse of similar software components, such as reduction
- Implementation using a Network protocol and Sockets or TCP

## 4 Example of the SIOX Interface

```
SIOX_send_descriptor(  
  unid_a, "K",  
  "FileName", "File.txt");
```

```
SIOX_map_descriptor(  
  unid_a,  
  "FileName", "File.txt",  
  "FileHandle", "17");
```

```
fh_a = open("File.txt");
```



```
SIOX_send_descriptor(  
  unid_b, "K",  
  "FileName", "File.txt");
```

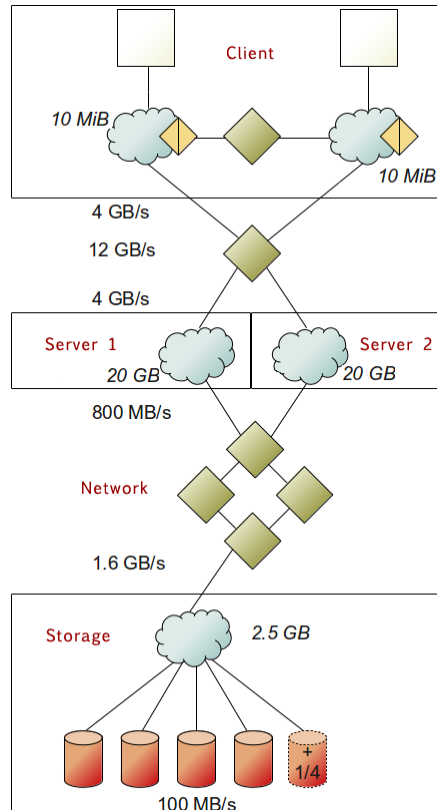
```
SIOX_map_descriptor(  
  unid_b,  
  "FileName", "File.txt",  
  "FileHandle", "16");
```

```
fh_b = open("File.txt");
```

```
SIOX_receive_descriptor(unid_k, "FileName", "File.txt");  
SIOX_receive_descriptor(unid_k, "FileName", "File.txt");
```

```
SIOX_map_descriptor(unid_k, "FileName", "File.txt", "FileHandle", "16");  
SIOX_map_descriptor(unid_k, "FileName", "File.txt", "FileHandle", "17");
```

## 5 Example I/O Path



- Abstract modeling approach: I/O Path model
- Caches are shown as clouds.
- Two clients access two servers over one network switch.
- Transfer rates are indicated between abstract nodes.
- All data going in one level equals data going out that level.

## 6 Addressing Overhead: Intelligent Reduction of Data Volume

- Store only relevant data
- Amount of I/O-Calls prohibits the storage of all access and performance information.
  - Start with low log level
  - Give individual SIOX nodes short term ring memory
  - Adjust granularity of protocols dynamically
- Discard duplicates
- Compression

## 7 Conclusion

Where is the I/O bottleneck in the HPC system ?

What is the solution to the bottleneck ?

How do we measure, recognize the specific problem  
and how do we optimize access paths ?

The SIOX system aims to give answers to these questions.

A holistic approach to data collection and aggregation allows the SIOX system to access the all software and hardware layers.

The causal relationship can be implied by creating a graph analog to the I/O path model.





Thank You All

We are looking for partners