SciHDF5: Integrating SciDB with the HDF5 File Format

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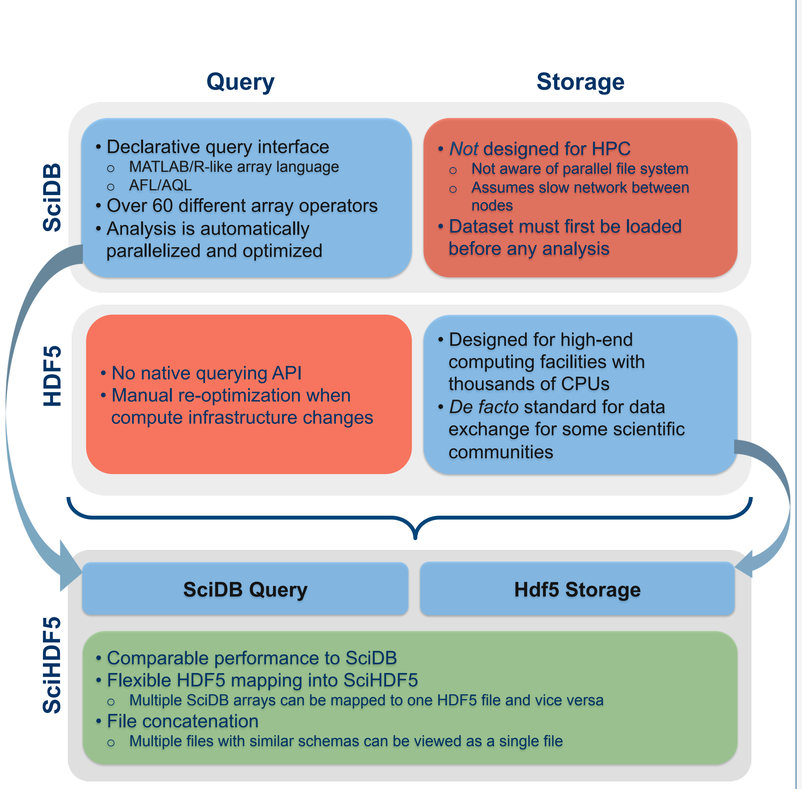
Motivation

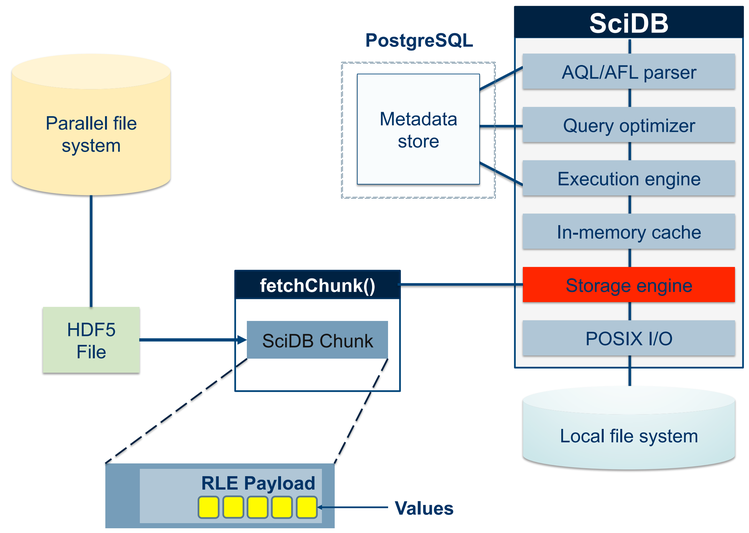
Large-scale experiments are often accompanied with massive datasets. In many cases, scientific experiments need to meet very fast access requirements in complex datasets. A well-known technology that is being used to meet these requirements is the hierarchical Data Format (HDF5). Another system for large scale analysis often adopted by the scientific community is SciDB, a parallel array database.



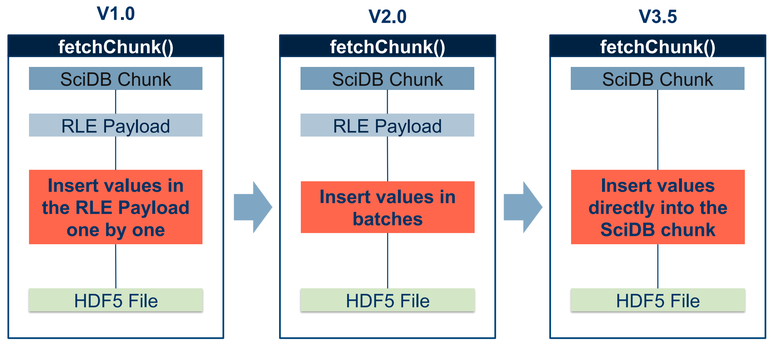
How to Use SciHDF5

1. Declare SciDB array using the prefix "SciHDF5"
2. CREATE ARRAY now creates a SciDB object that contains "SciHDF5 attributes"
3. Every "SciHDF5 attribute" should be defined in the scihdf5.config file
4. Every "SciHDF5 attribute" corresponds to one HDF5 dataset
5. An "SciHDF5 attribute" can be mapped to multiple HDF5 files that contain the same HDF5 dataset
6. Queries touching this SciDB object read/write data directly from the HDF5 file

SciHDF5 Architecture

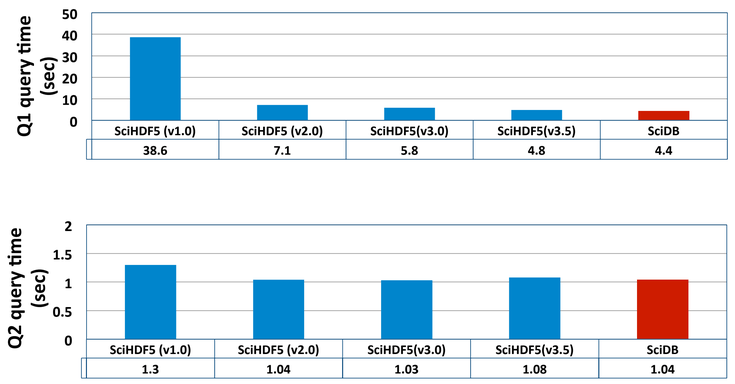


SciHDF5 Optimizations



SciHDF5 versus SciDB

We compare the above SciHDF5 optimizations to the original SciDB using a synthetic dataset of 10GB and 8 SciDB/SciHDF5 instances. The first query (Q1) is an aggregation over the entire dataset and the second one (Q2) is a random selection of 1 million elements.

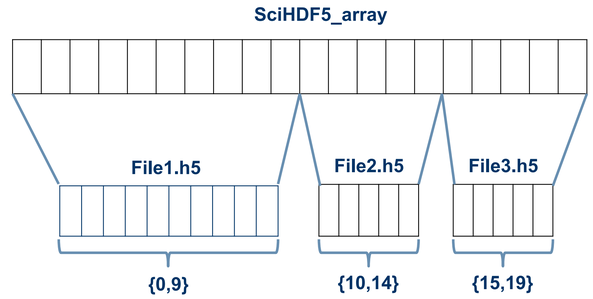


Additional Functionality

- **Users can define an HDF5 object in different ways**
  - One SciDB array with hdf5 attributes that are mapped to different HDF5 files.
  - Many SciDB arrays with hdf5 attributes that are mapped to the same HDF5 file.
- **File concatenation**
  - If specified, SciHDF5 can assume that multiple HDF5 files are concatenated.
  - First file in the "scihdf5.config" followed by the second file etc.
- **Declaration of the SciDB array**

  "CREATE ARRAY SciHDF5_array <attribute_1, attribute_2> [i=0:20,10,0]"
- **scihdf5.config**

```
line 1: #HDF5 attributes
line 2: [attribute_1]
line 3: file = /path/to/file1.hdf5;/path/to/file2.hdf5;/path/to/file3.hdf5
line 4: dataset = /h5_group1/h5_dataset1
line 5:
line 6: [attribute_2]
line 7: file = /path/to/file1.hdf5;/path/to/file2.hdf5;/path/to/file3.hdf5
line 8: dataset = /h5_group2/h5_dataset2
```



LUX/LZ Use Case Results

Our results are based on calibration data of the LUX/LZ detector that was build to analyze interactions from galactic dark matter. The original data sample contains 233 files with a total size of 1GB. For the purpose of this experiment, the dataset was duplicated 16 times. A cluster of 16 SciHDF5 instances were used to perform a query that analyzes the entire dataset such as calculating min, max and average values.