Conditions data payload management with Rucio

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GWSC GRAVITATIONAL WAVE SCIENCE CENTER

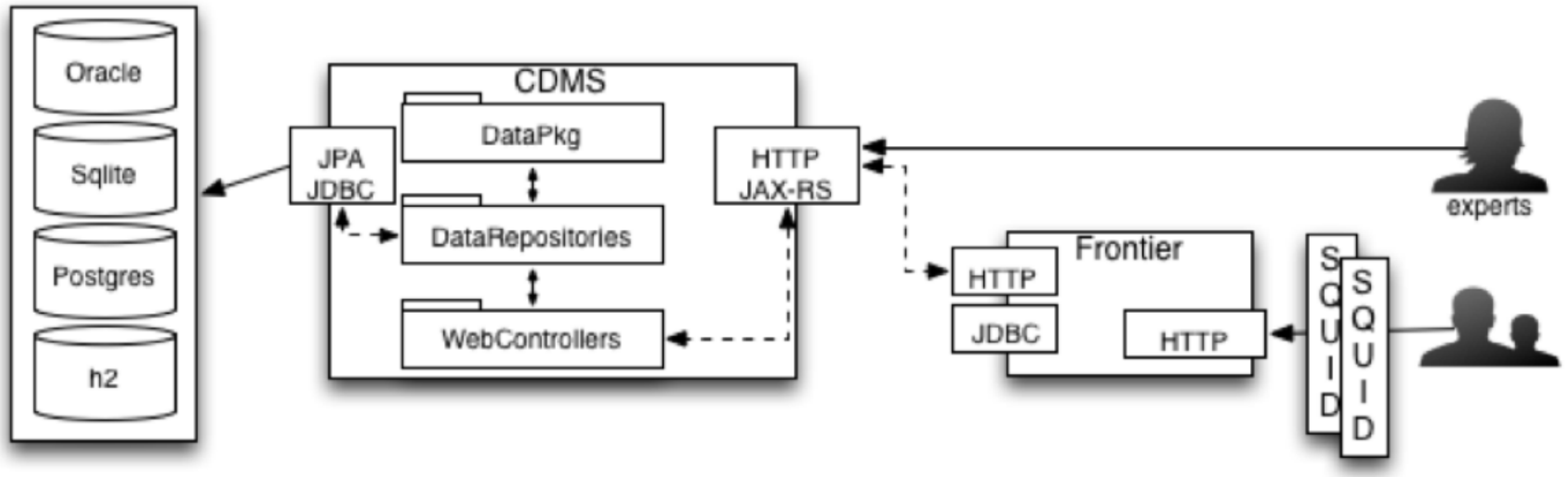
References

- https://arxiv.org/pdf/2401.16274 - The HSF CDB Reference Implementation
  - And CHEP talk https://indico.jlab.org/event/459/contributions/11326/attachments/9582/14015/conditions_db_reference_implementation_chep_2023.pdf
- https://iopscience.iop.org/article/10.1088/1742-6596/331/4/042008/pdf - Frontier
- https://arxiv.org/pdf/1901.05429 - The HSF Conditions Data white paper
- https://doi.org/10.1051/epjconf/202429501013 - Towards a new conditions data infrastructure in ATLAS

- Figures taken, context hopefully (!) retained

Conditions data

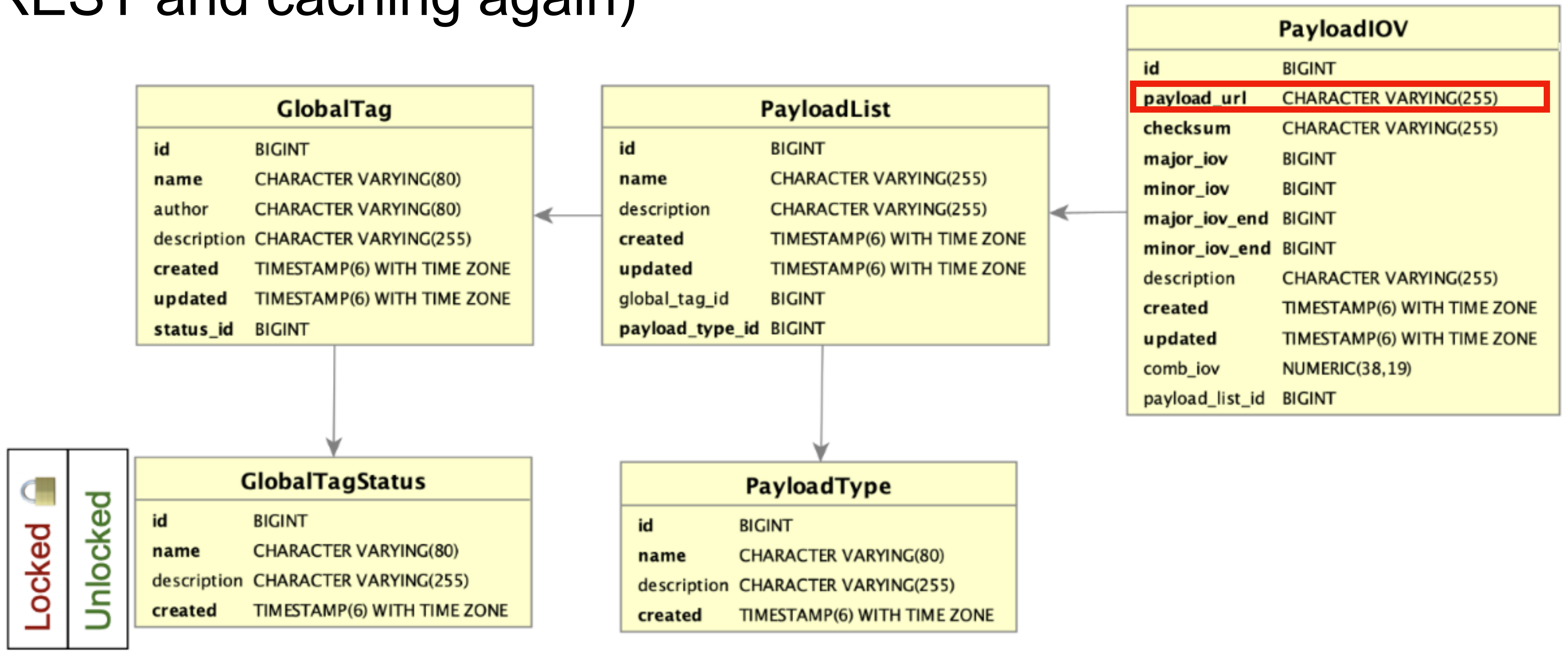
- Conditions data is… Everything apart from the “event” data that needs to be pulled into a data processing job, e.g. detector calibrations, slow control information (usually at coarse granularity)
    - Many jobs need the same conditions data
- Typically lives in a database and often still does



HSF CDB design

- Commonality between the experiment use cases led to a common understanding of best practice
  - Factorise metadata queries from payload queries (caching)
  - Keep it simple (caching again)
  - Loose coupling between client and servers (REST and caching again)

- HSF schema (right) - metadata lives in an RDB
  - Payloads are referenced by URL
- Payloads live… elsewhere (not in the DB)
- Implementation details, YMMV



GlobalTag

id	BIGINT
name	CHARACTER VARYING(80)
author	CHARACTER VARYING(80)
description	CHARACTER VARYING(255)
created	TIMESTAMP(6) WITH TIME ZONE
updated	TIMESTAMP(6) WITH TIME ZONE
status_id	BIGINT

PayloadList

id	BIGINT
name	CHARACTER VARYING(255)
description	CHARACTER VARYING(255)
created	TIMESTAMP(6) WITH TIME ZONE
updated	TIMESTAMP(6) WITH TIME ZONE
global_tag_id	BIGINT
payload_type_id	BIGINT

PayloadIOV

id	BIGINT
payload_url	CHARACTER VARYING(255)
checksum	CHARACTER VARYING(255)
major_iov	BIGINT
minor_iov	BIGINT
major_iov_end	BIGINT
minor_iov_end	BIGINT
description	CHARACTER VARYING(255)
created	TIMESTAMP(6) WITH TIME ZONE
updated	TIMESTAMP(6) WITH TIME ZONE
comb_iov	NUMERIC(38,19)
payload_list_id	BIGINT

GlobalTagStatus

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PayloadType

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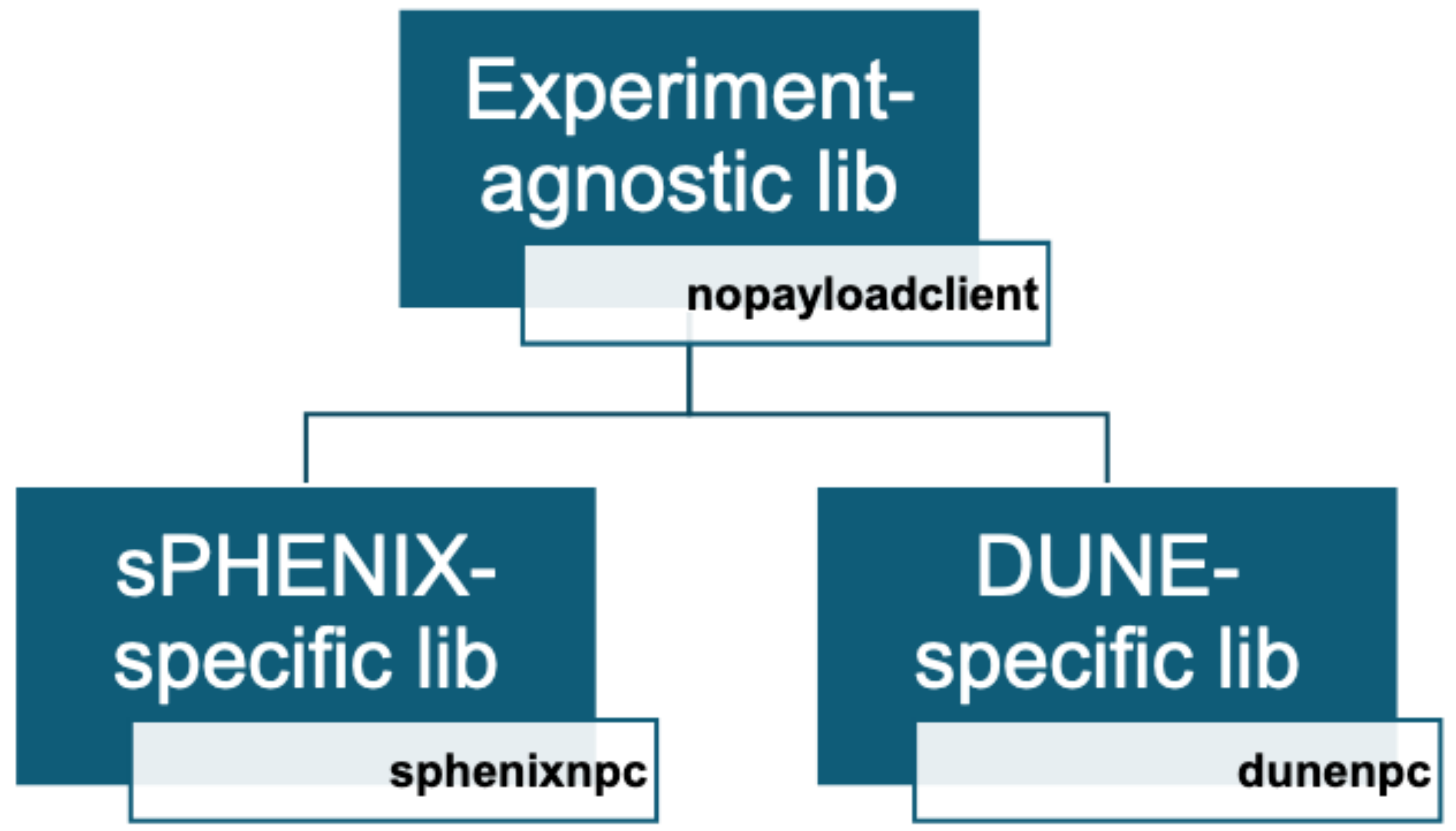
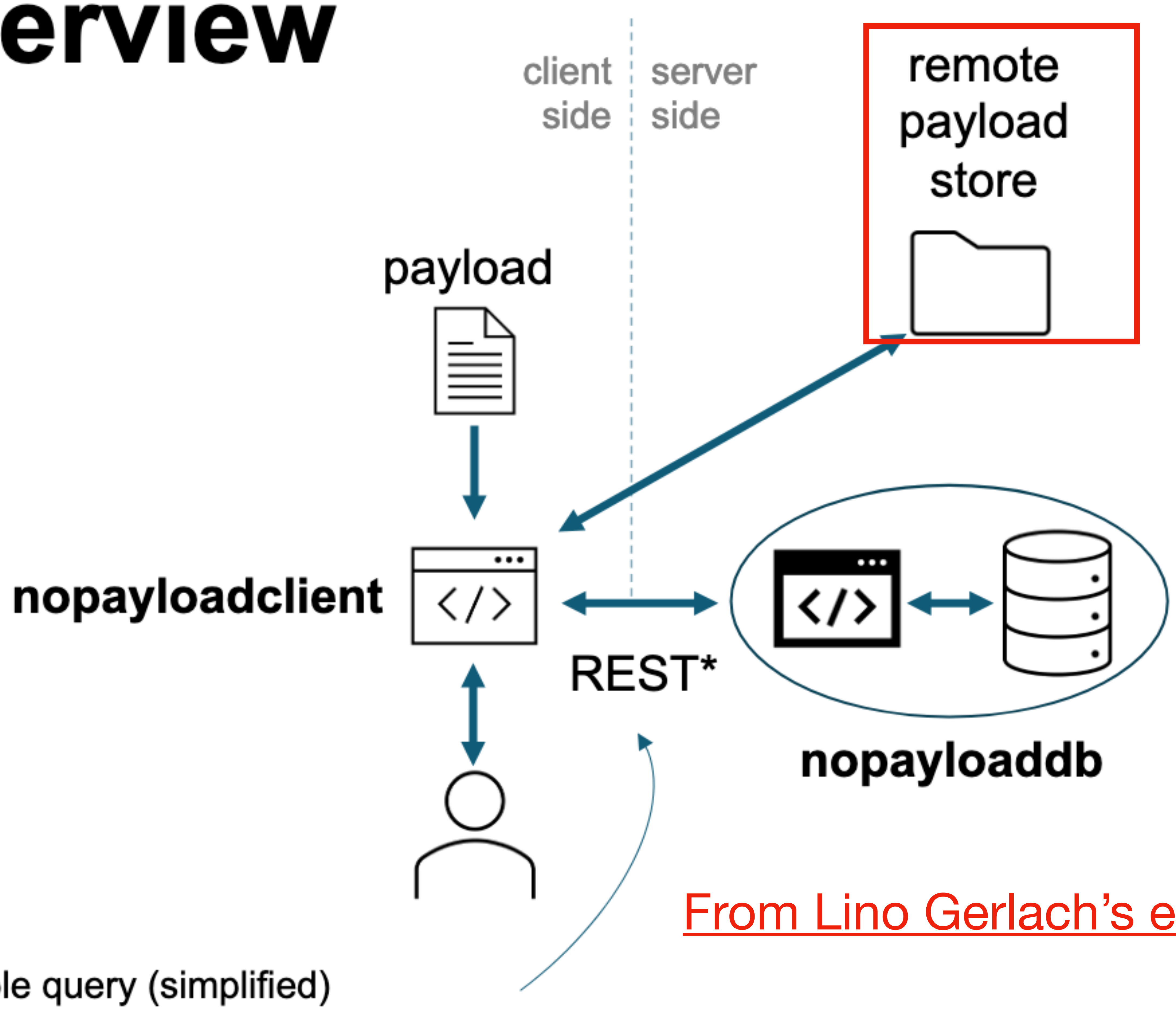
Implementation – Overview

nopayloadclient:

- Client-side stand-alone C++ tool
- Communicates with **nopayloaddb** (server)
- Local caching
- Handling of payloads





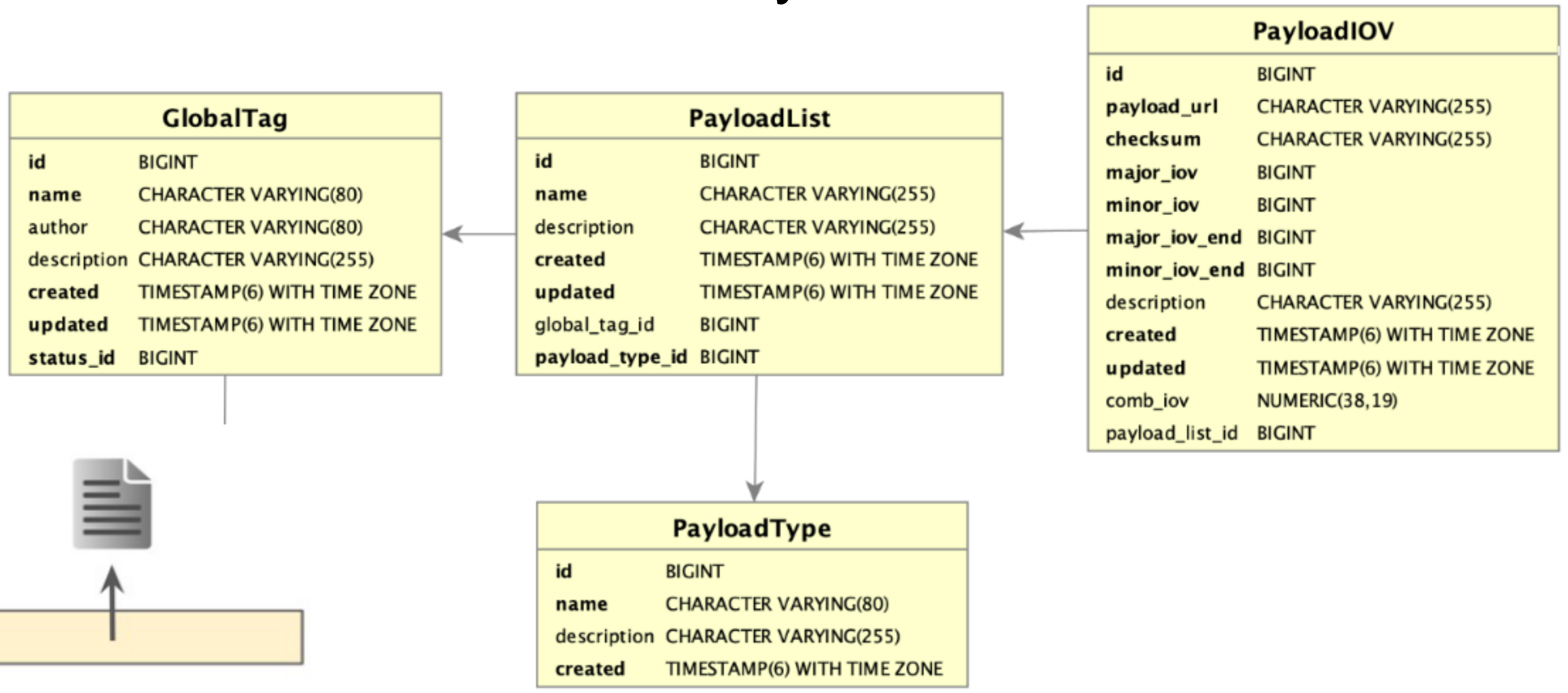
From Lino Gerlach's excellent CHEP talk

*Example query (simplified)

```
curl http://<host>/api/payloadiovs/?gtName=test_gt&iovNum=42
-> {type_1: url_1, type_2: url_2, …}
```

HSF CDB organisation

- At the job configuration level, a job needs to know which GlobalTag (global version) this job needs
- For every conditions payload type, data are organised in lists of “intervals of validity”



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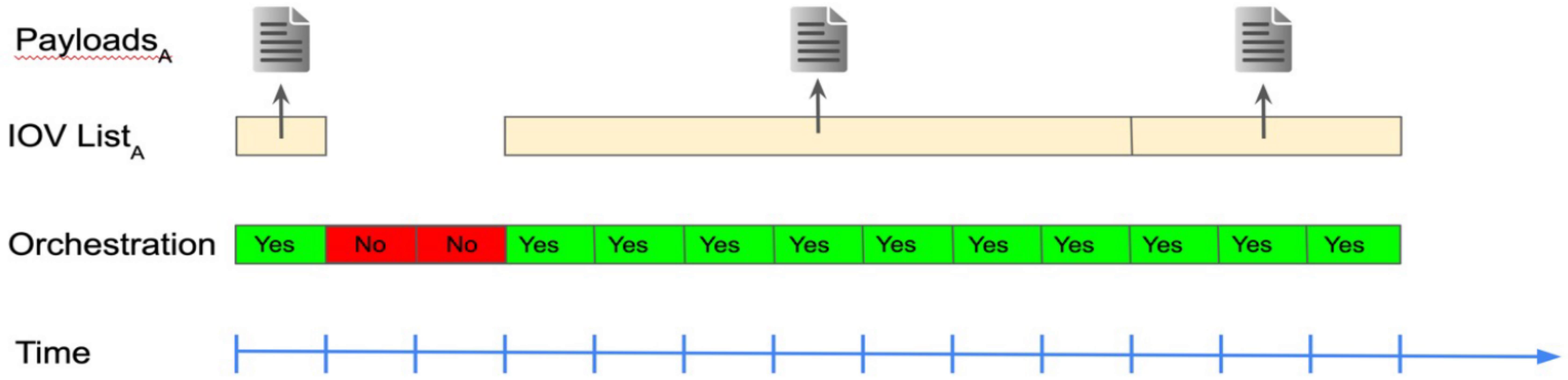
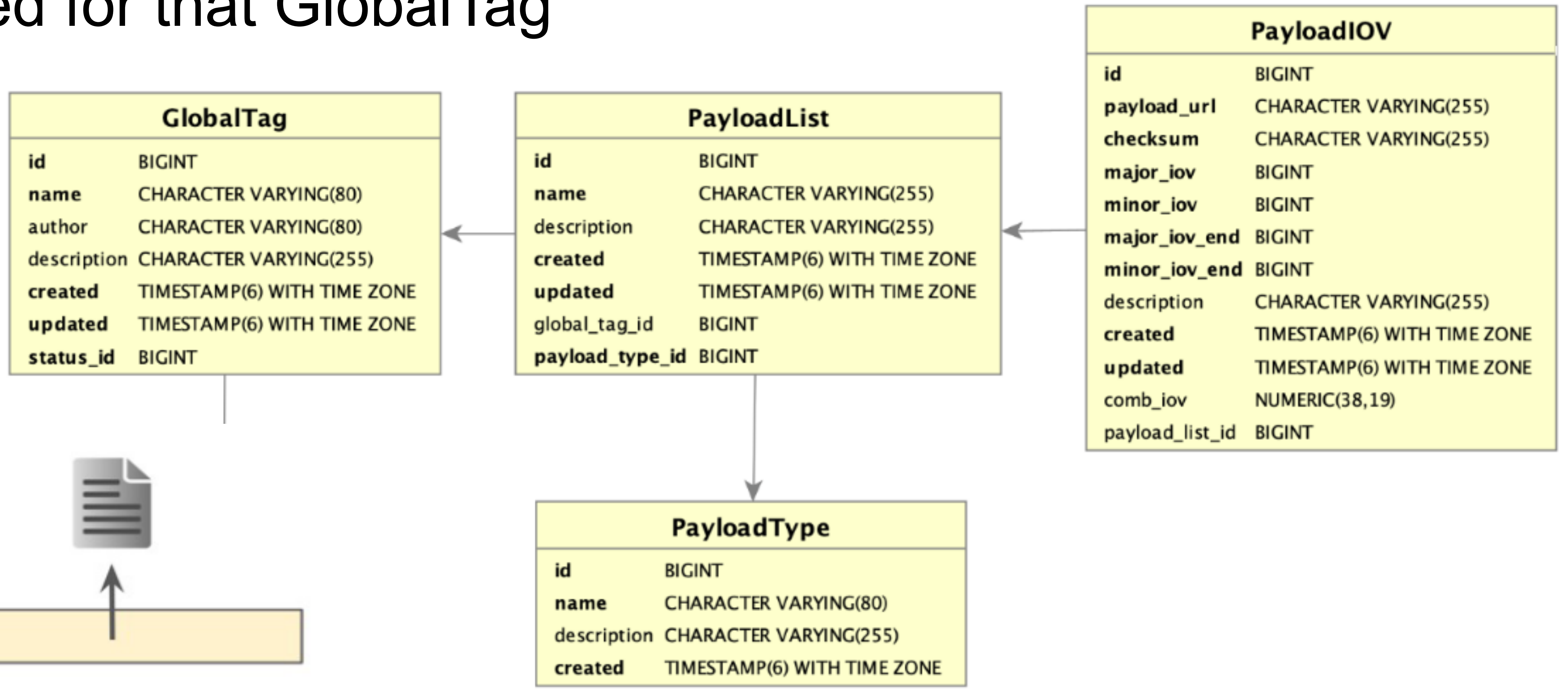


HSF CDB organisation

- In terms of data management, a GlobalTag (global version) defines all of the conditions payload files for e.g. a particular MC processing campaign: ***<u>GlobalTag -> list of files</u>***

- Could think of using Rucio to manage a dataset defined for that GlobalTag



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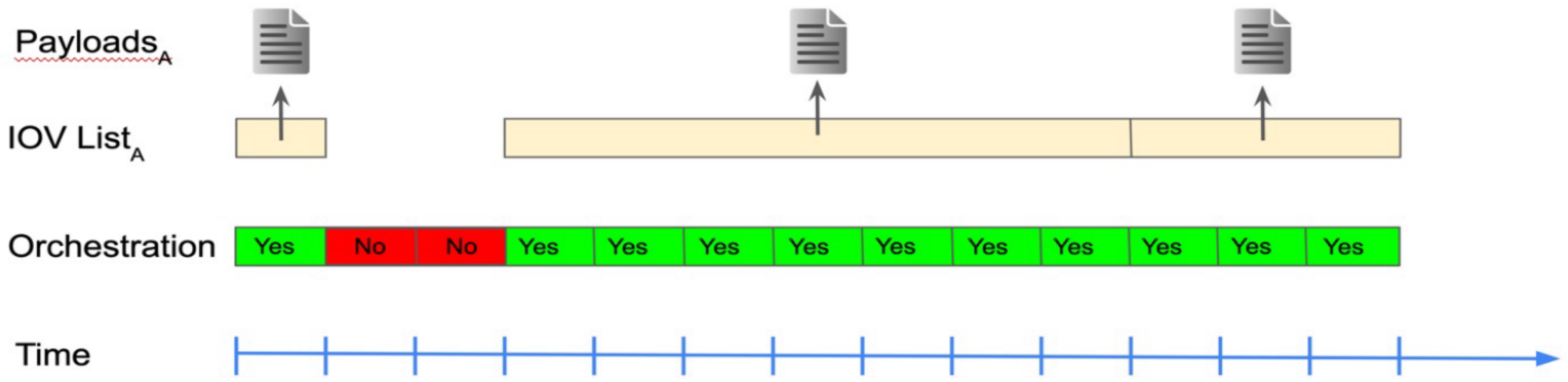


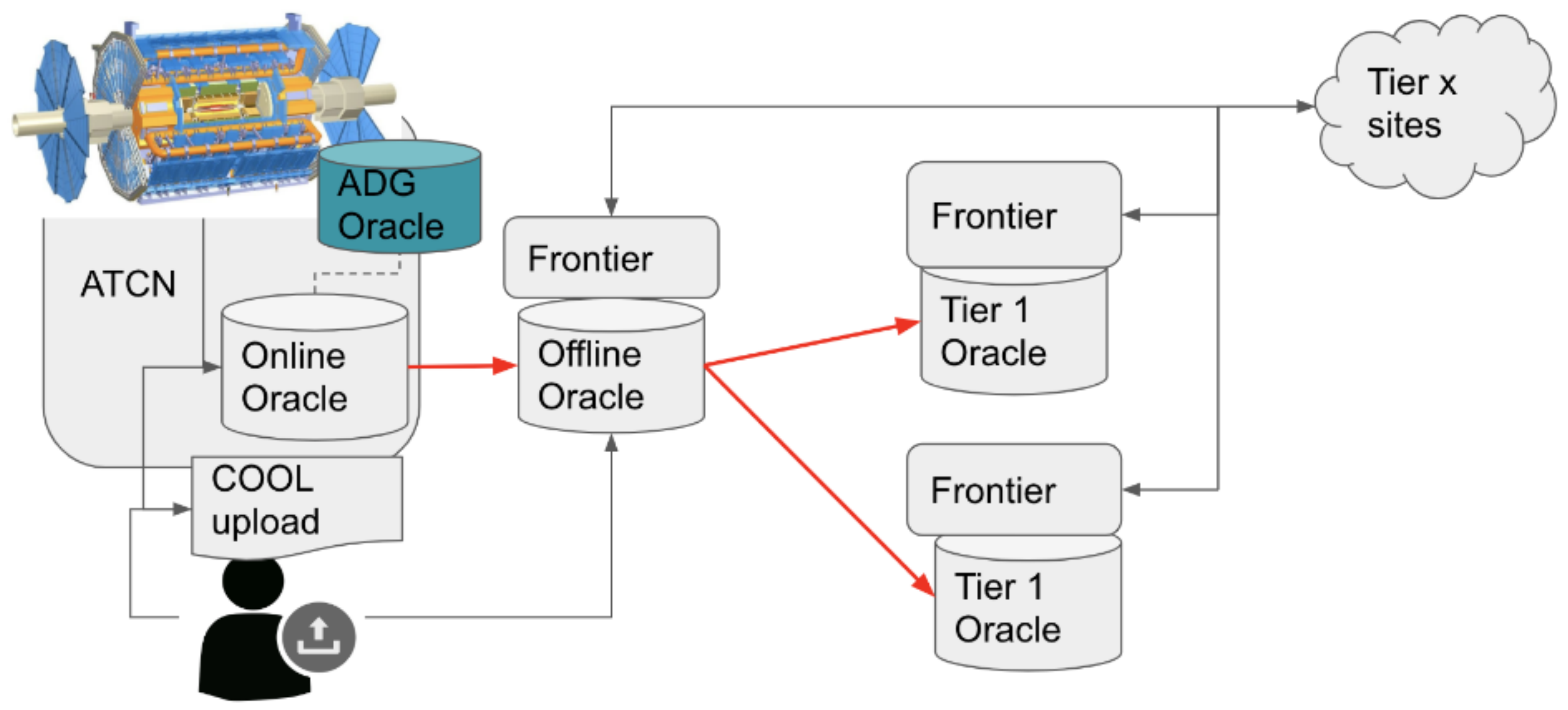
HSF CDB organisation

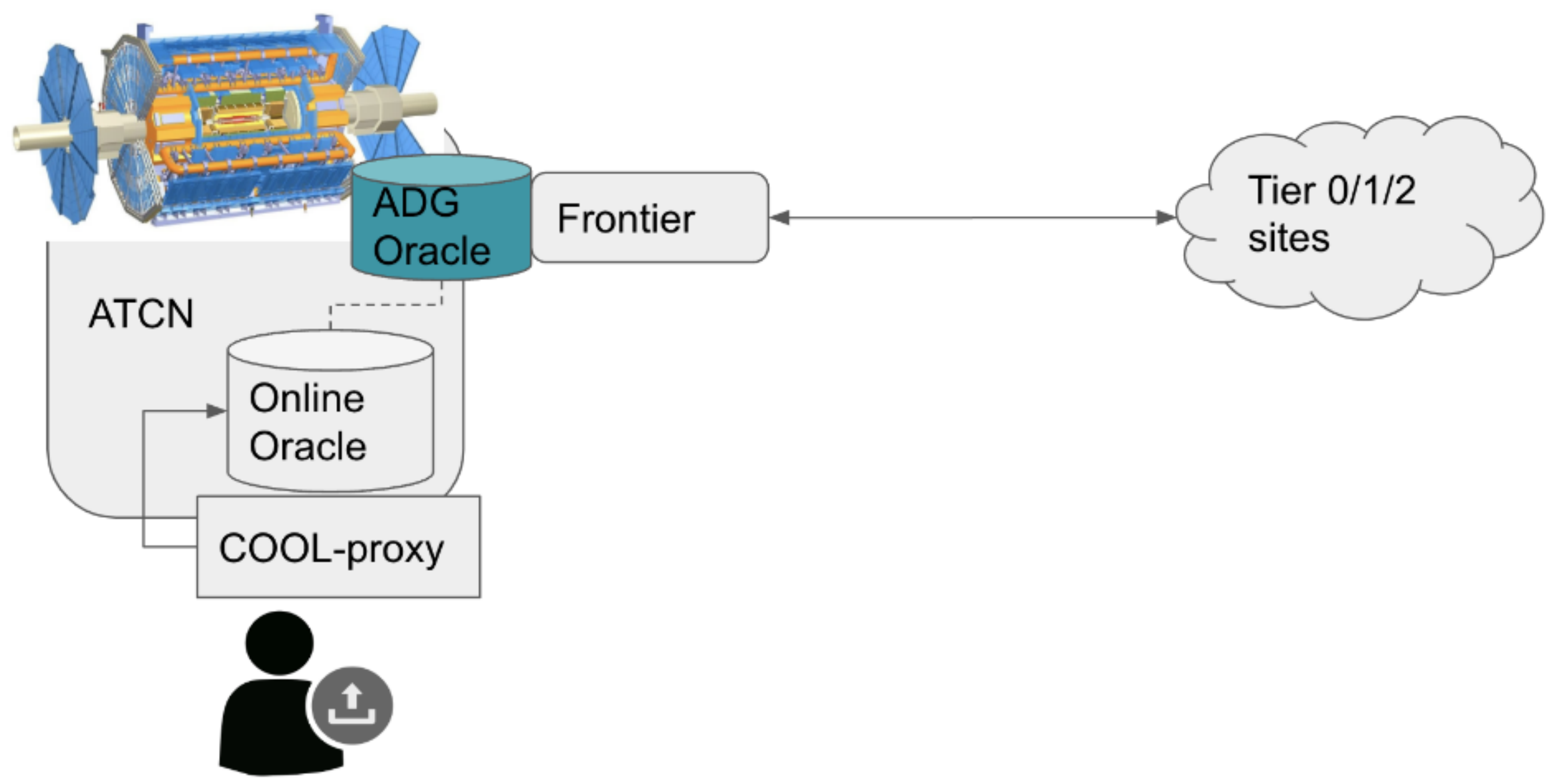
- In terms of data management, a GlobalTag (global version) defines all of the conditions payload files for e.g. a particular MC processing campaign: ***GlobalTag -> list of files***
- Could think of using Rucio to manage a dataset defined for that GlobalTag
- Used for e.g. I need to know which conditions payloads I need to send to my HPC site
  - Answer - it’s this Rucio dataset (MyConditionsGT), Rucio, please do your thing
- It could more generally be used to make replicas of conditions datasets
  - Hey Rucio, I’d like to have my conditions datasets at these sites
  - Caveat, conditions files are accessed by many jobs

HSF CDB design

- The HSF CDB design makes the payloads portable, change the storage endpoint by changing the prefix (LFN to PFN) - a configuration parameter of the HSF CDB client
- Used to determine payload service failover strategy, an example access failover pattern:
  - Check locally
  - (Check cvmfs for Belle II, works for published GTs that have been pushed there)
    - Cvmfs is a good solution for a lot of use cases, but ad hoc file storage seems like a bit of an abuse.
  - Check the main CDB service
- The server is usually protected by a cache
  - Frontier (ATLAS and CMS), or squid caches at particularly heavy sites (Belle II)
  - Many jobs hit the same files so caching is really essential

Offline ATLAS

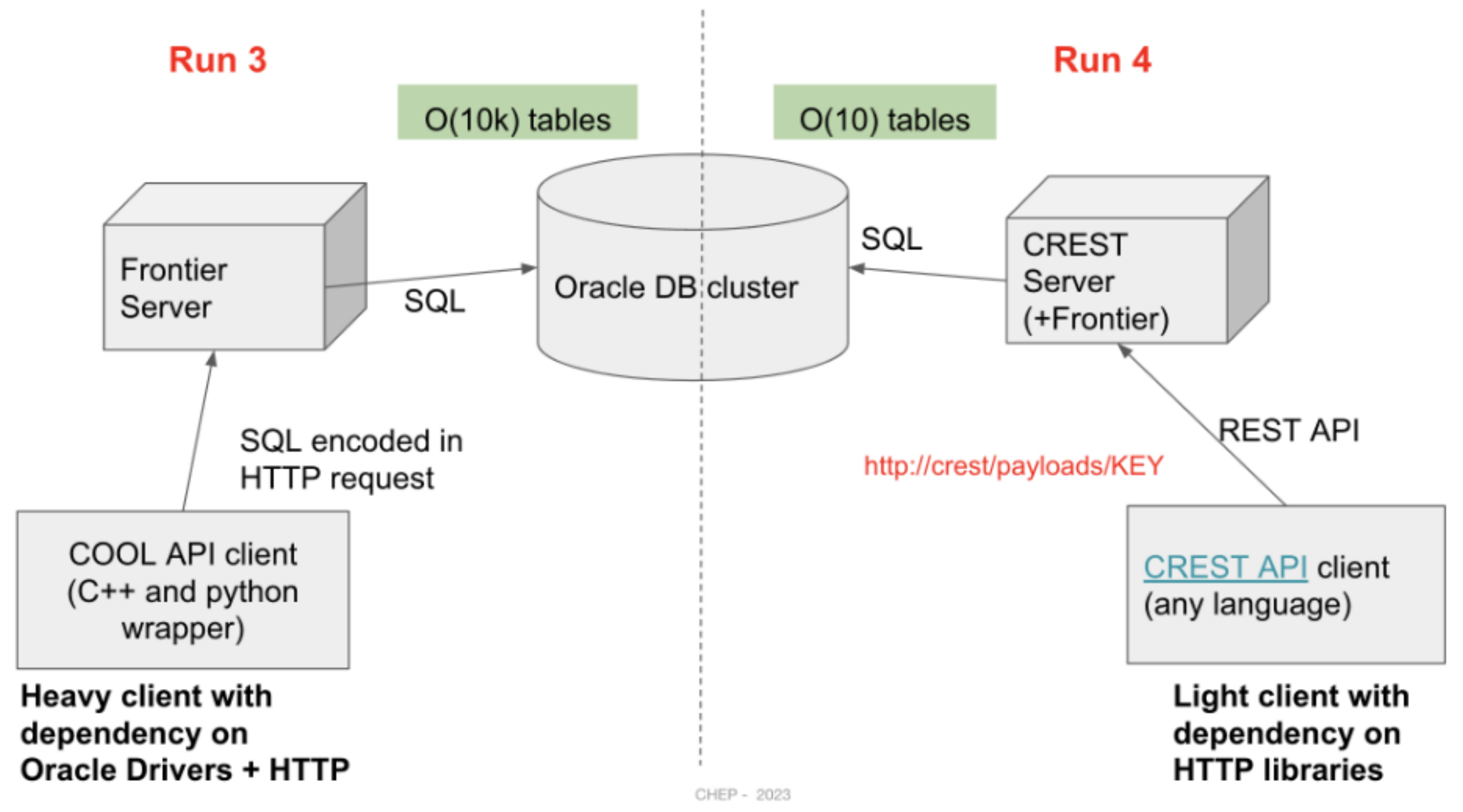




- pre-Run 3 (left) using Oracle Golden Gate, Run 3 (right) with no Golden Gate (and no Oracle outside CERN).
- In Run 3 all access from outside CERN goes via a read-only replica (ADG), protected by Frontier

- Figures from the ATLAS CHEP 2023 paper: https://doi.org/10.1051/epjconf/202429501013 - “Towards a new conditions data infrastructure in ATLAS” - mis-interpretations are mine !

Offline ATLAS


Run 3
Run 4
O(10k) tables
O(10) tables
Frontier Server
SQL
Oracle DB cluster
SQL
CREST Server (+Frontier)
SQL encoded in HTTP request
REST API
http://crest/payloads/KEY
COOL API client (C++ and python wrapper)
CREST API client (any language)
Heavy client with dependency on Oracle Drivers + HTTP
Light client with dependency on HTTP libraries
CHEP - 2023

- For Run 4, remove the dependence on COOL and replace with CREST

Offline - what if?

- Offline use case (e.g. from a software framework) looks like:
  - Query the CDB service (REST API) to ask WHICH conditions files I need
  - LFN->PFN retrieve the actual files from storage using my preferred failover strategy
- **What if the job told the CDB client where to find conditions data (known by Rucio)**
  - This is a one-off configuration at the start of a job
- **What if you could easily send conditions data to more (“all”?) of your sites (typically small data volumes)**
  - Would you ?
  - Typically have squid caches at big sites, effectively doing that at those sites (for some subset of the data)
  - These conditions files must be accessed by many jobs which is why Frontier has been so important for ATLAS and CMS
  - Latency means this is likely best used for “frozen” GlobalTags, but that’s still a lot of jobs

Online

- What it won’t do… the online use case is special and will continue to need something like the current solutions

Discussion

- At the point that conditions data payloads live on a file system, it’s intriguing to think about managing them and their access like “any other data”, and Rucio does that well !
    - The database part of CDB management is to answer the question of WHICH data do I need for this particular job, after that the retrieval of the conditions data files is just file retrieval
- At least for creating exports of conditions data for e.g. HPC processing use cases, it could be useful
- For more generally distributing replicas of conditions datasets, if this is useful, it might be “easy” (full disclosure, I have not gone further than a thought experiment !)
    - With that caveat that these files are accessed by many jobs
    - And the need for the RDB for metadata (and caching those queries) remains
- DISCUSS !