LHCb Software Architecture
GAUDI

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Project Scope

- We are developing a *Framework* to be used in ALL the LHCb event data processing applications including all stages: high level trigger, simulation, reconstruction, analysis.

  The Framework are the foundations and the walls of a house that has been designed but still needs to be filled/completed to be fully functional.

Framework goals

- The bulk of the LHCb data processing software will be developed by physicists.
- The Framework should:
  - Allow physicists to focus on solving the physics problem.
  - Ensure low coupling between concurrent developments.
  - Guarantee a later smooth integration of developments.
  - Facilitate software re-use.

Overall software project planning

- We plan to have major milestones every 2 years. Major project reviews (technologies, methods, quality, etc.)
- First big milestone: mid 2000.
  - Migration to object-oriented completed.
  - Retirement of the “old” software.
- We plan to go in short cycles (2-3 months) of incremental implementation and release.
  - Feedback from users at each stage.
  - Set priorities for what the following release should contain.

Architecture Design

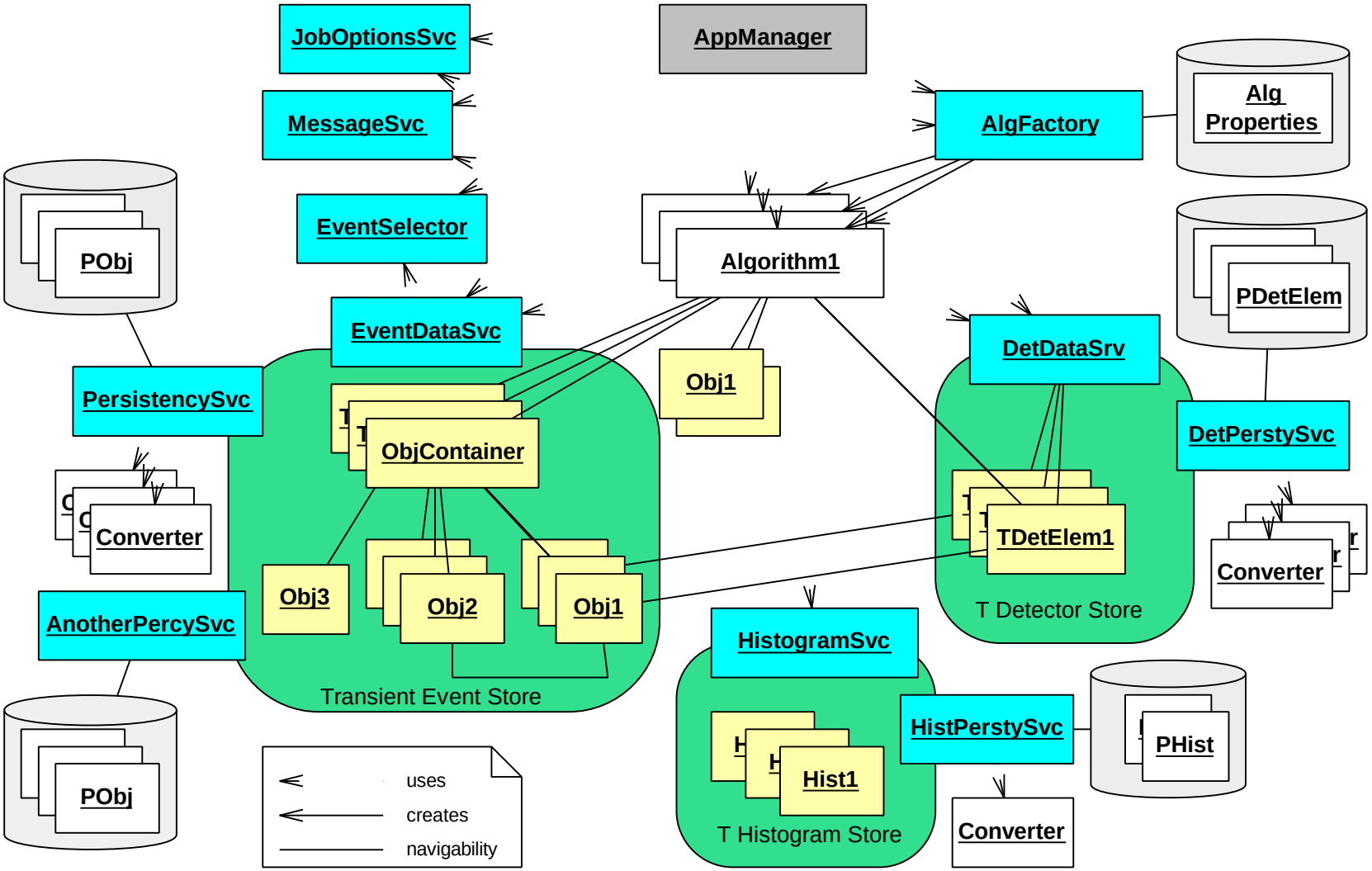
Major design criteria

- Clear separation between “data” and “algorithms”
- Three basic types of data:
  - **event data** (data obtained from the particle collisions)
  - **detector data** (structure, geometry, calibration, alignment, environmental parameters,..)
  - **statistical data**: (histograms, …)
- Clear separation between “persistent data” and “transient data”.
  - Isolation of user’s code.
  - Different/incompatible optimization criteria.
  - Transient as a bridge between various representations.

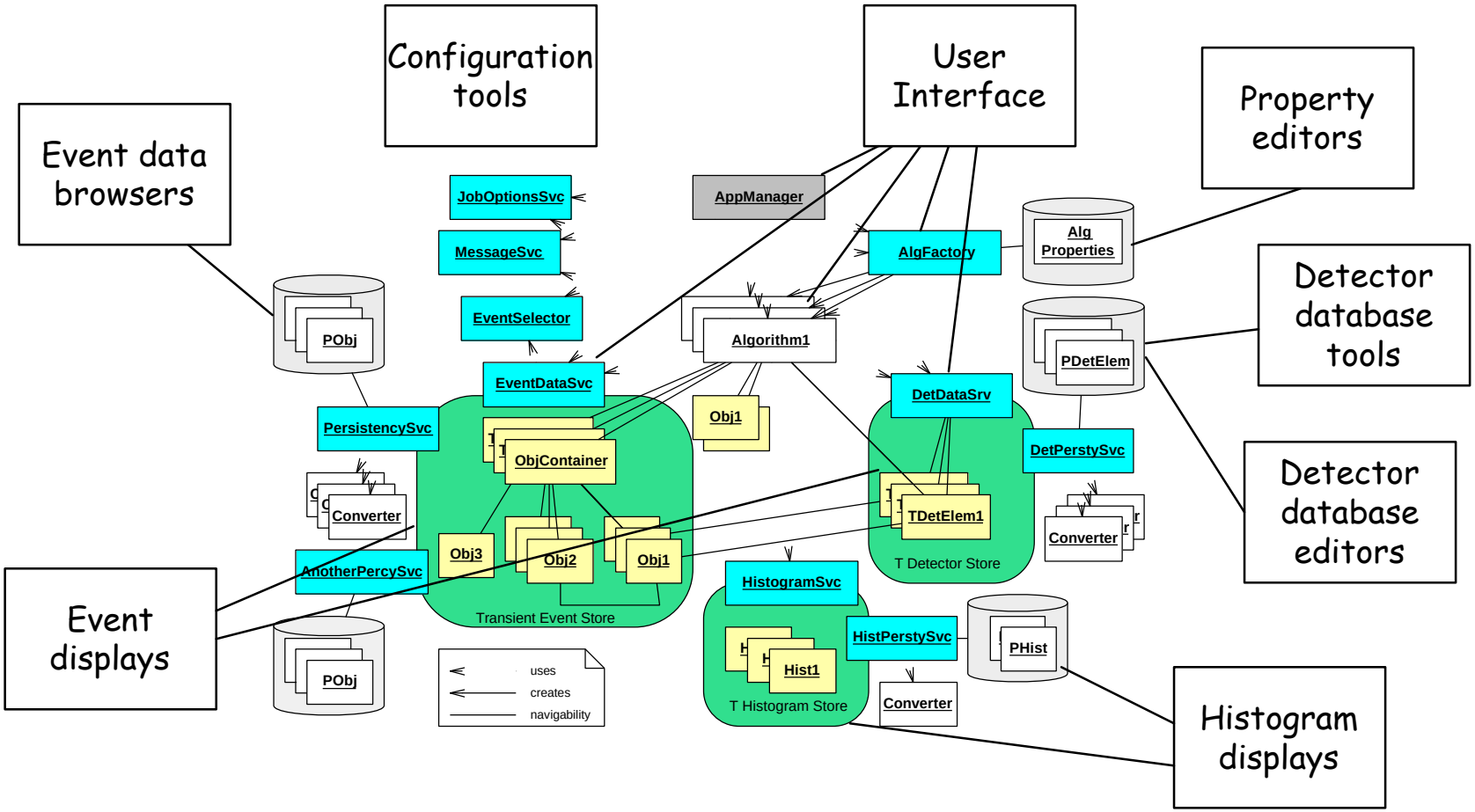
Major design criteria (2)

- Data store centered architectural style.
  - Algorithms as data producers and consumers.
- *User code* encapsulated in few specific places:
  - "Algorithms": Physics code
  - "Converters": Converting data objects into other reprentations
- All components with well defined "interfaces" and as "generic" as possible.
- Re-use components where possible
- Integration technology standards

Architecture: Object Diagram



What was not shown

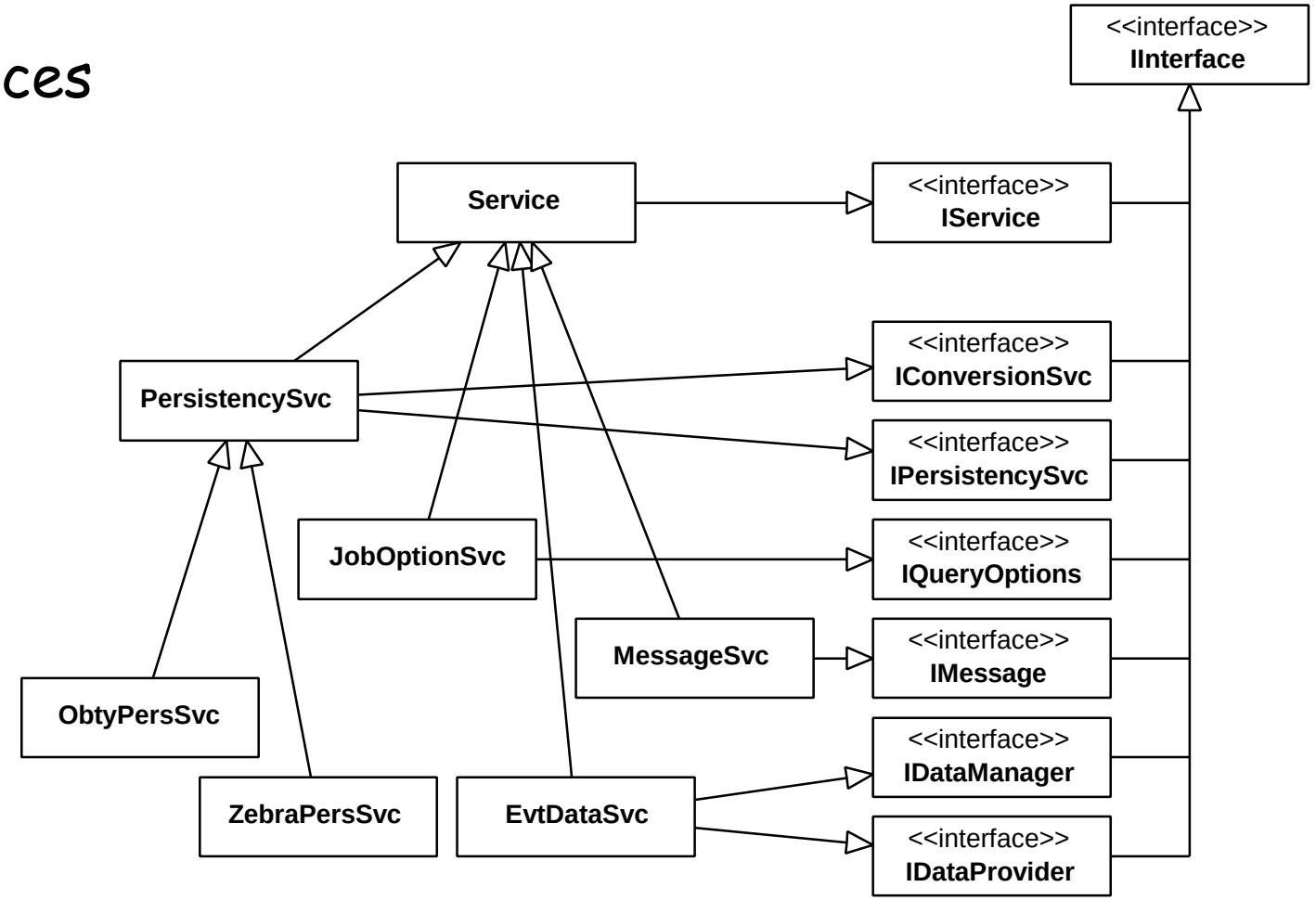


Architecture:Classification of Classes

Application Managers	One per application. The "chef d'orchestra".
Services	Offering specific services with well-defined interfaces. Different concrete implementations depending of specific functionality.
Algorithms	Physics code. Nested algorithms. Simple and well defined interface.
Converters	In charge of converting specific event or detector data into other representations.
Selectors	Components to process a selection criteria for events, parts of events or detector data.
Event/Detector data	The data types that the algorithms and converters are using. No complex behavoir.
Utility classes	All sort of utility classes (math & others) to help on the implementation of the algorithms.

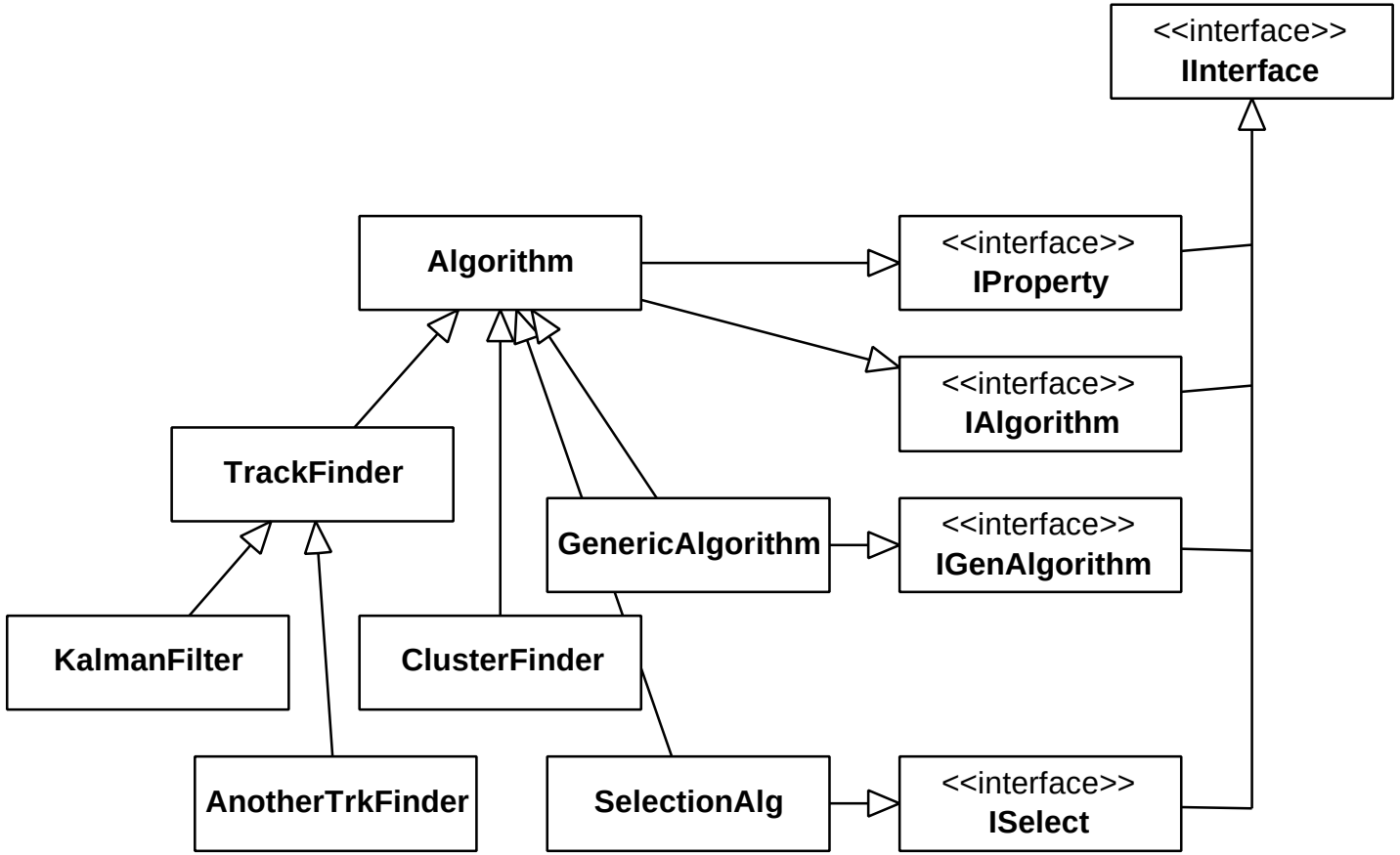
Architecture (class diagrams)

Services

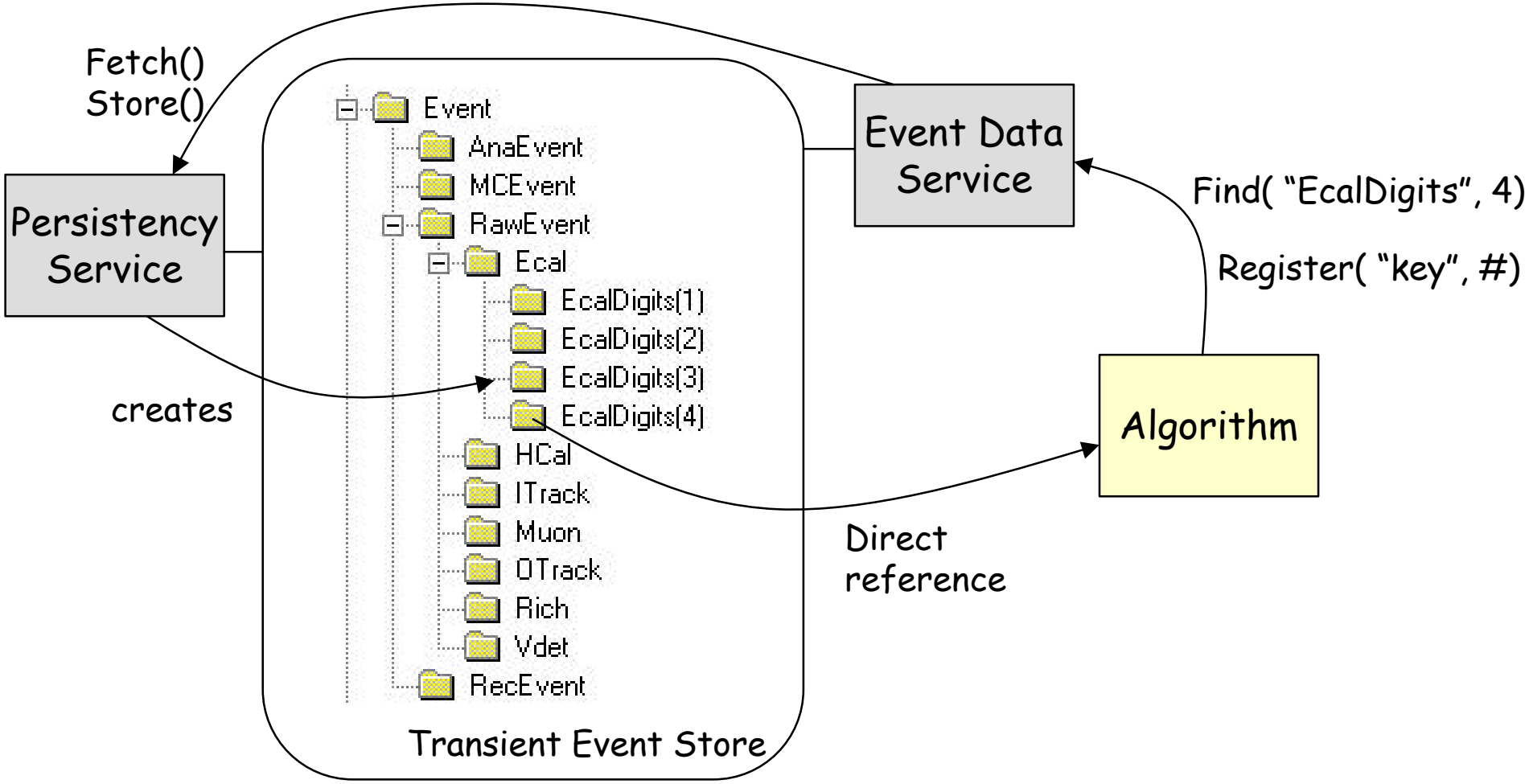


Architecture (class diagrams)

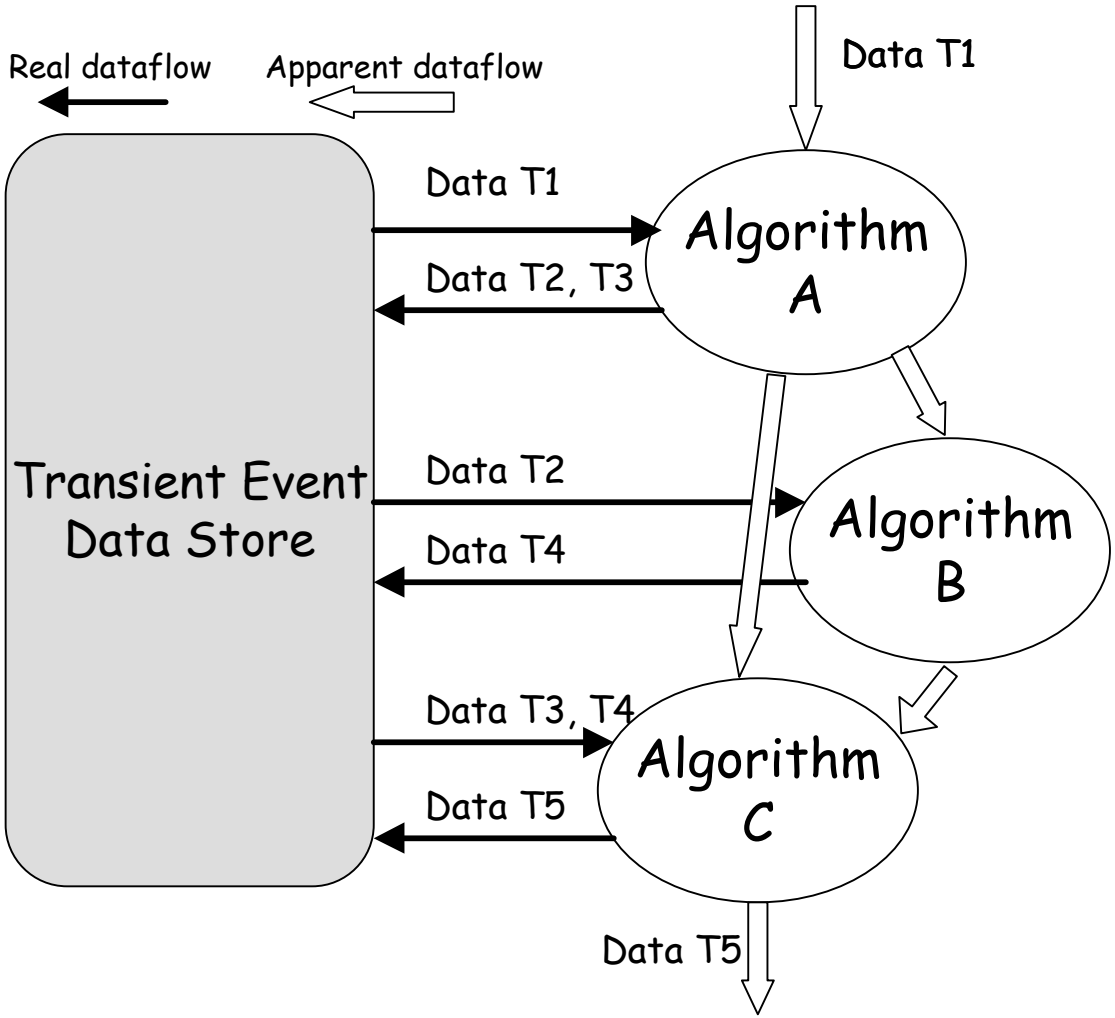
Algorithms



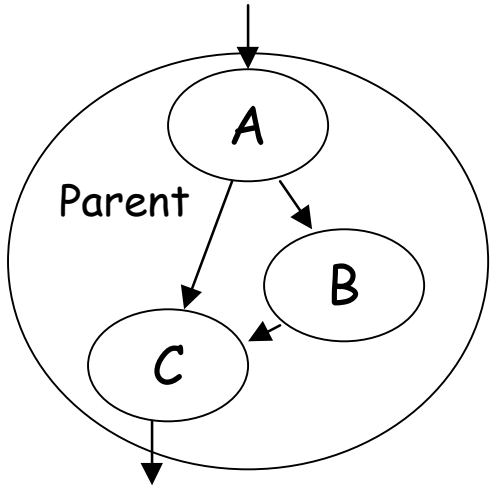
Transient Event Store



Algorithms & Transient Data Store



- Each Algorithm only knows what data (type and name) is expecting as input and creating as output.
- The only coupling is through the data.
- Scheduling of sub-algorithms is responsibility of the parent algorithm.

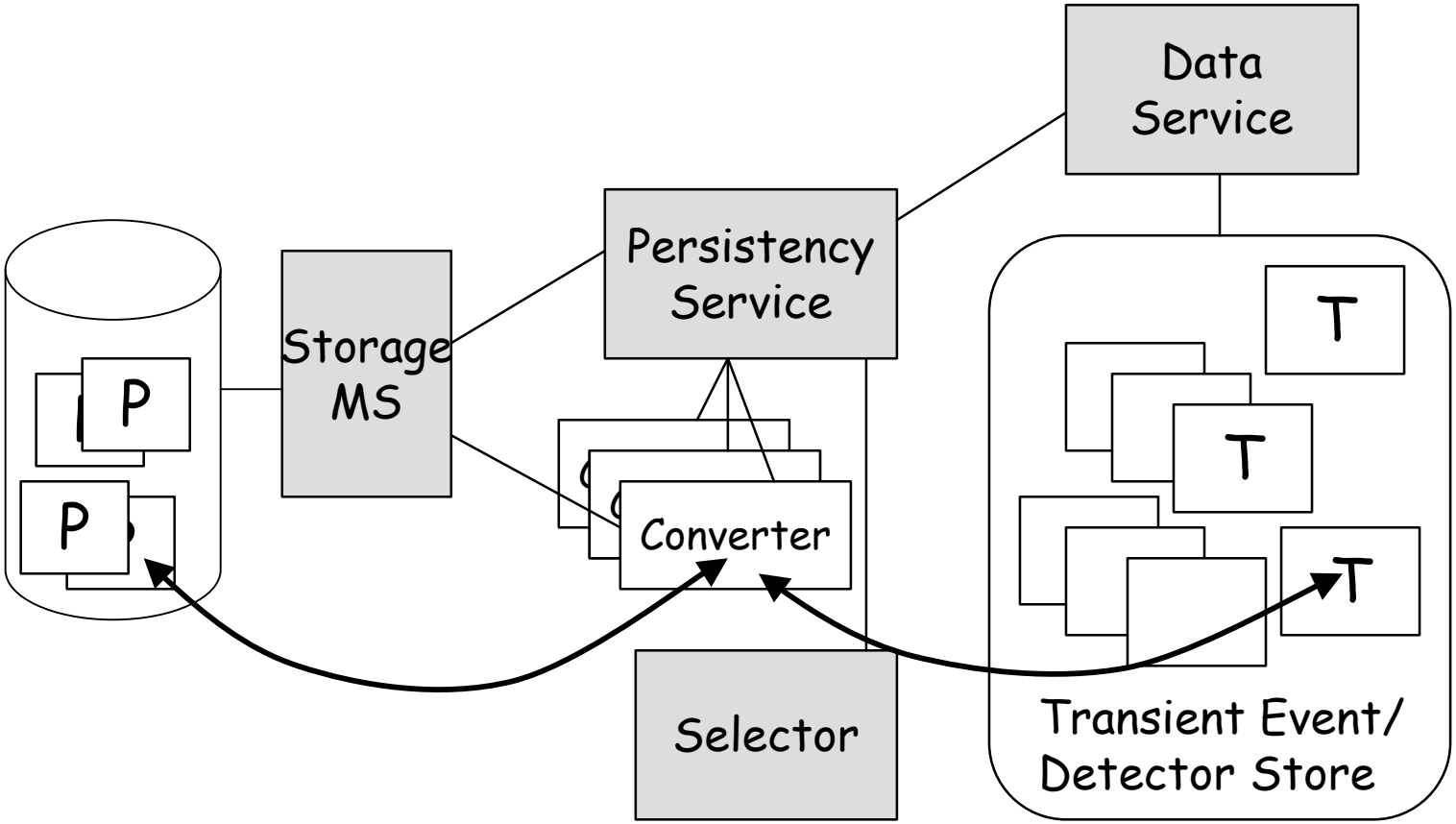


Algorithm code example

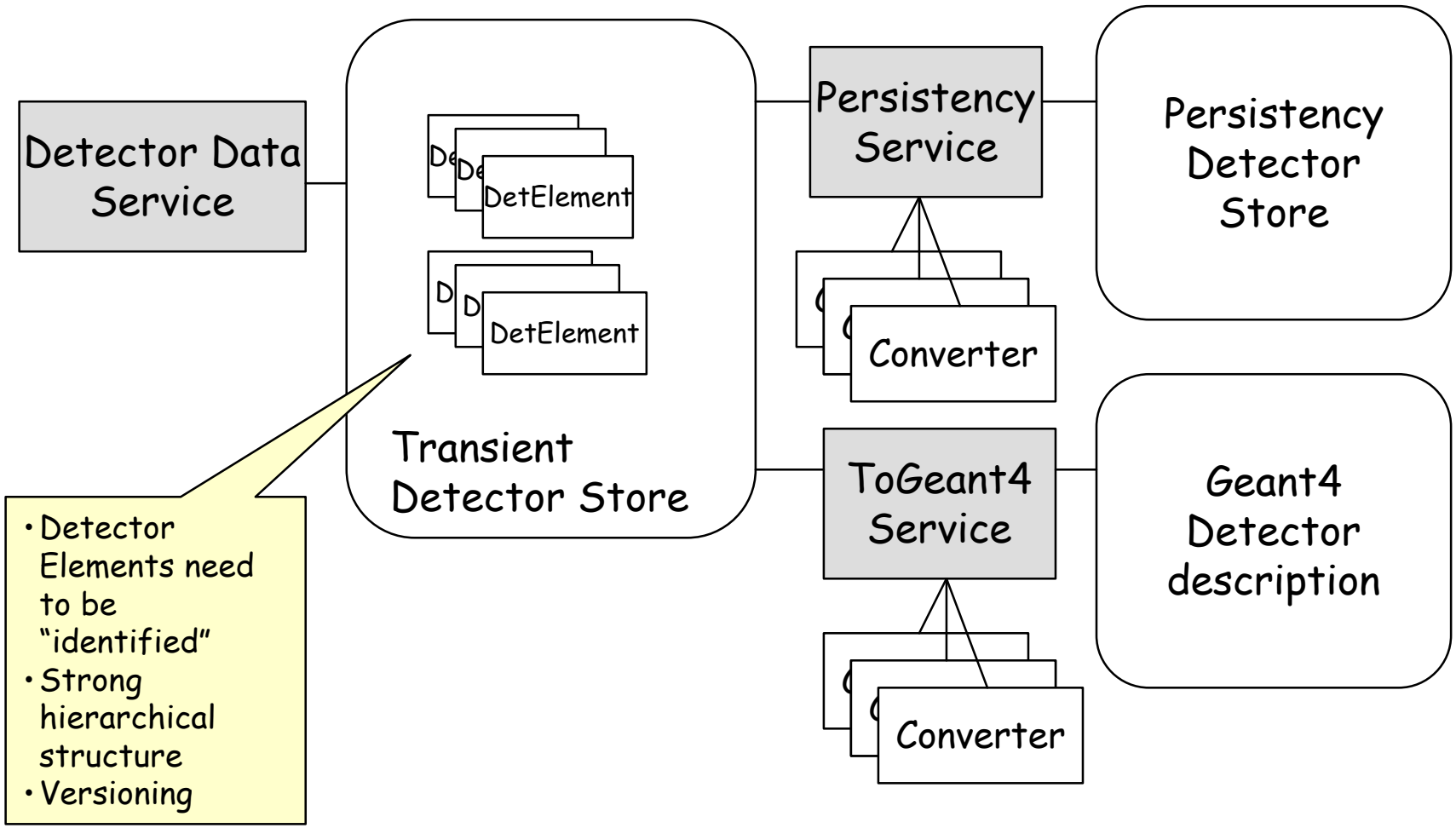
```
StatusCode TrackFitter::execute() {
  // Get the vertex hits from the EventDataSvc
  StatusCode sc;
  DataObject *pDO = 0;
  sc = eventDataSvc->findObject("/Event/RawEvent/Vdet/Station[1]/Clusters", pDO);
  // Check that the data was found
  if(SUCCESS != sc) {
    messageSvc->logFatalError("Cluster data not found in store");
    return sc;
  }
  // Data was found, cast to correct type
  ObjectSet<Cluster*> *clusters = dynamic_cast< ObjectSet<Cluster*>* >(pDO);
  // Create a track container object
  ObjectSet<Track*> *tracks = 0;
  tracks = new ObjectSet<Track*>("Tracks");
  // Use the clusters to produce Tracks
  // and place the tracks in a container
  tracks->push_back( .. );

  // Register the Tracks with the EventDataSvc
  sc = eventDataSvc->registerObject( "/Event/RecEvent/Vdet", tracks);
  // If the registration fails some cleanup must be done
  if(SUCCESS != sc) {
    messageSvc->logFatalError("Failed to register tracks");
    delete tracks;
    return sc;
  }
  return SUCCESS;
}
```

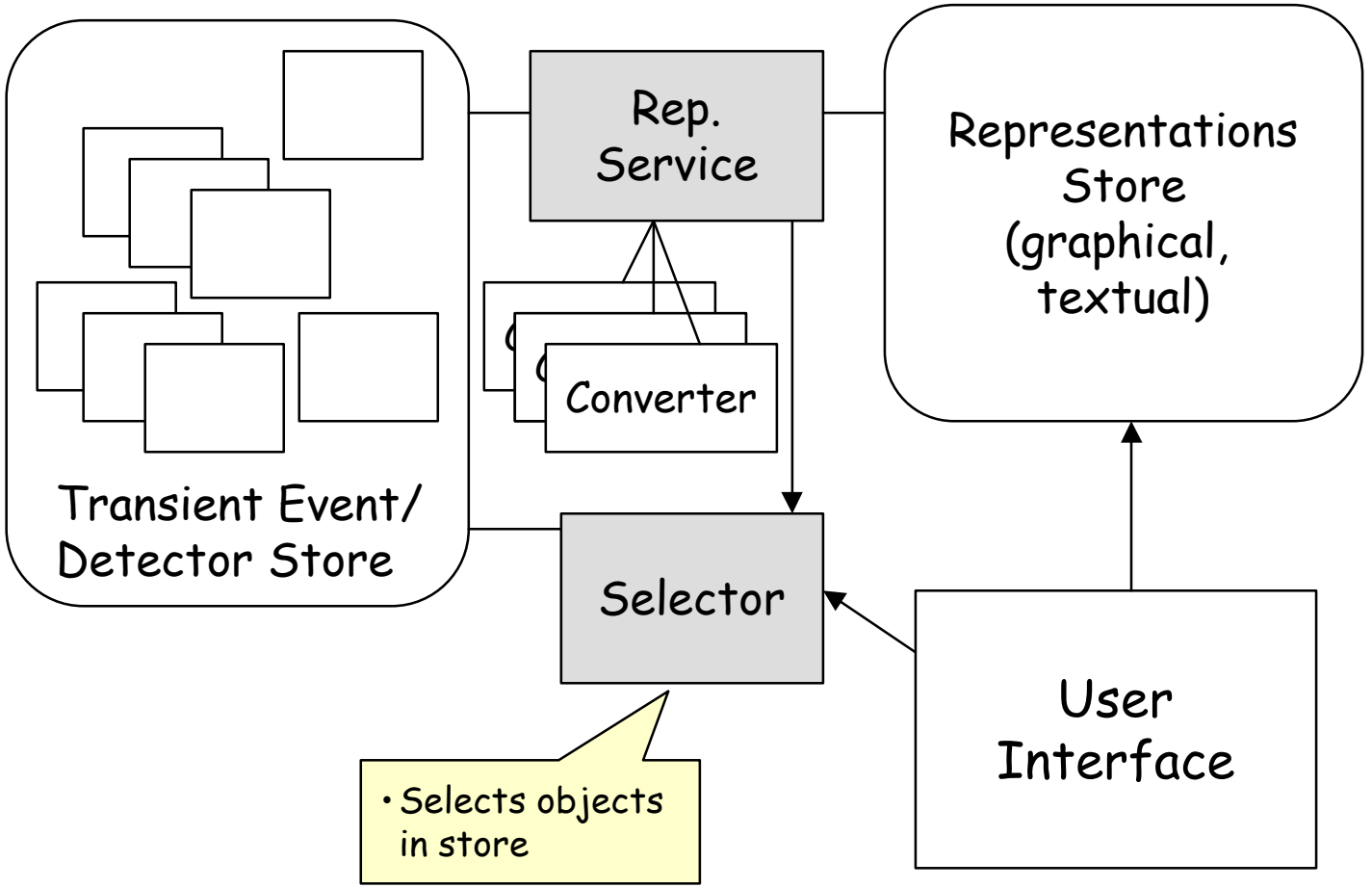
Transient/Persistent Data representations



Detector Data representations



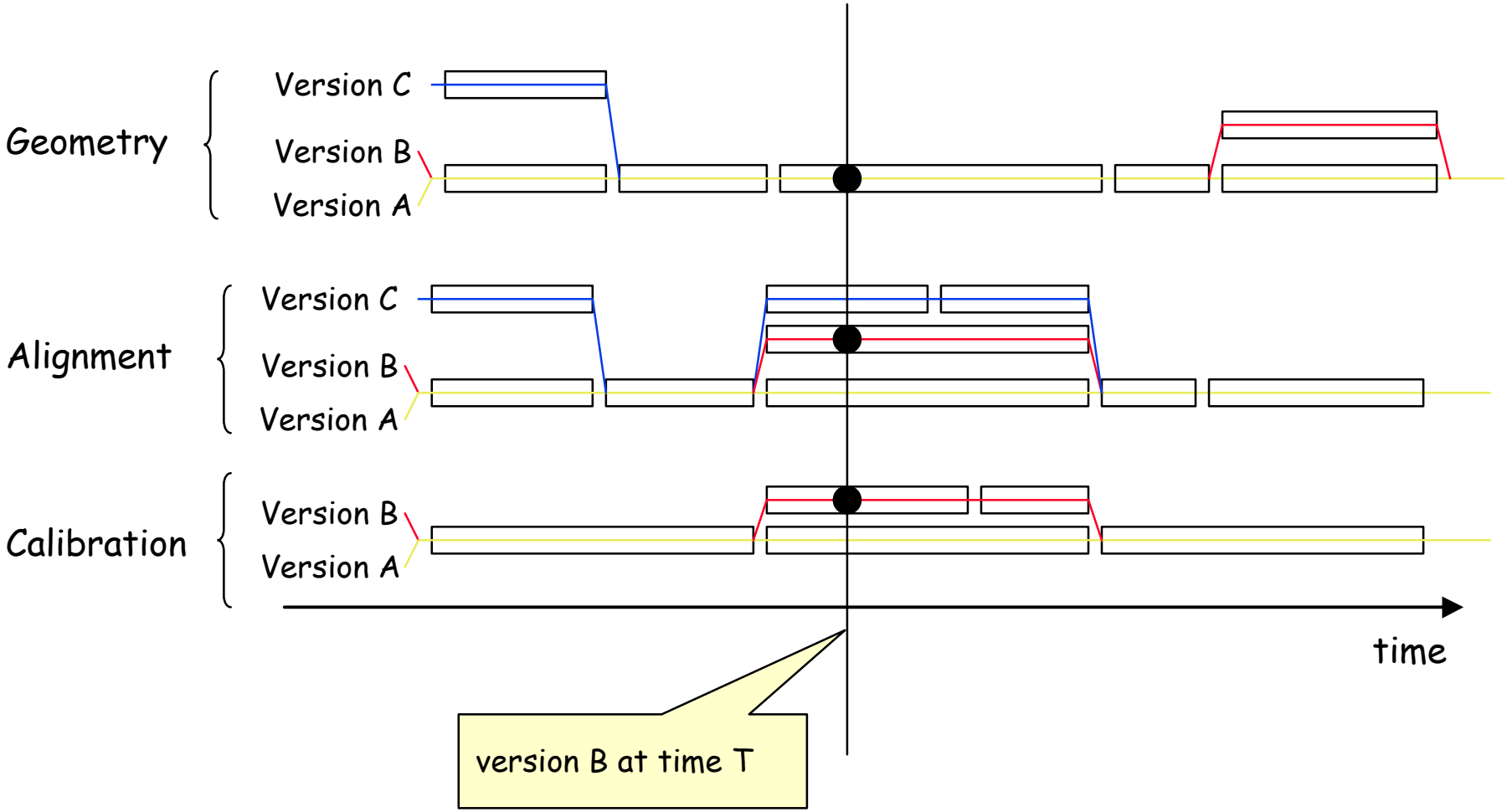
Visualization



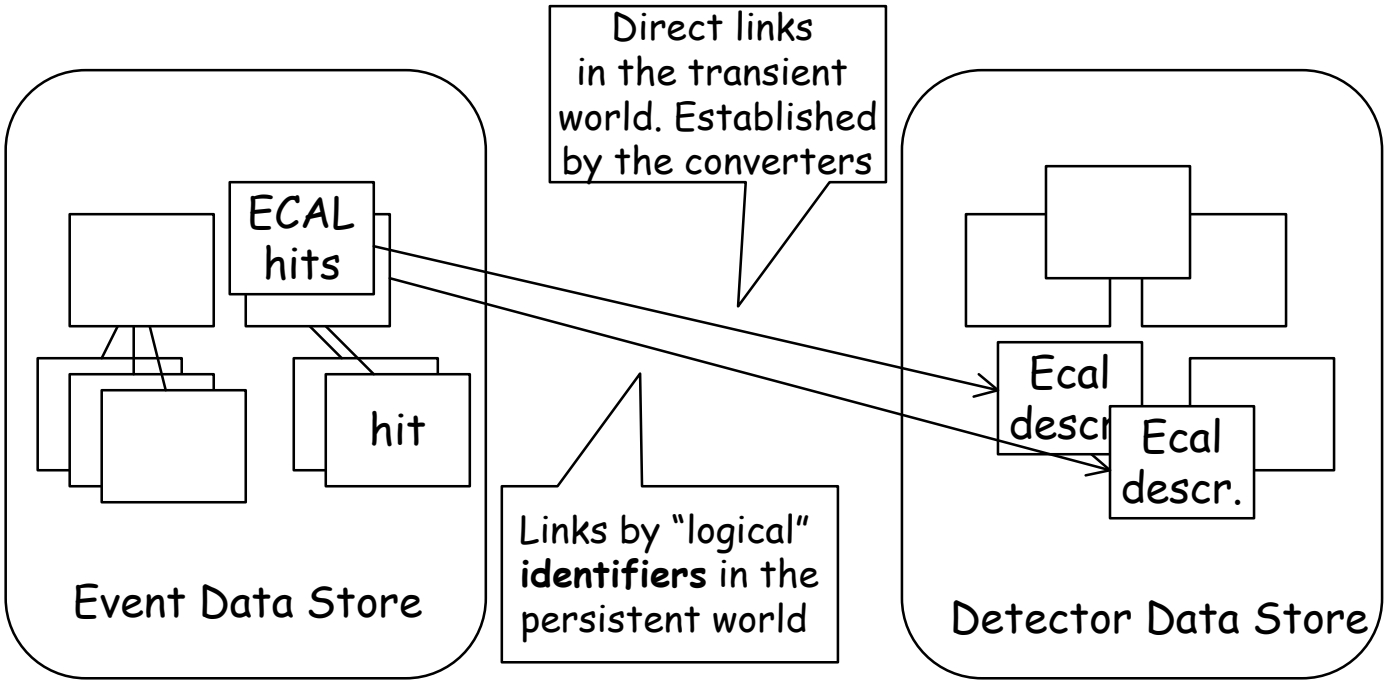
Detector Description

- It includes:
  - Detector structure (final detector, test beam, etc.)
  - Geometry & Positions (Ideal, Real, Simulation). Versioning based on time, run #, etc. Material.
  - Mapping electronic channels to detector cells. Dead channels.
  - Detector control data needed for reconstruction (time based).
  - Calibration and alignment data.
- The transient detector store contains a “snapshot” of the detector data valid for the event currently being process and a labeled version.

Detector Database



Links between Event/Detector



– A priori different "persistent stores". Logical identification needed.

Application Configuration

- What are the knobs at our disposal?
  - **JobOptions.** Simple usage. It allows the end-user to overwrite any property of any algorithm or service.
  - **Algorithm/Service properties database.** A more sophisticated way to modify the properties of the algorithms and services.
  - **Detector database edition** to create new versions or releases.
  - **Write specific code**. Configure your application by setting it at runtime.
  - **User interface component**. Graphical (a la Visual Basic), command line (scripting language), etc.