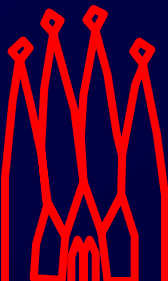


2

Introduction to Gaudi



LHCb Software Strategy

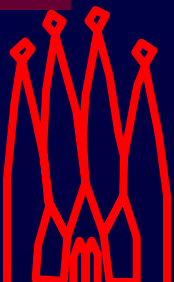
Develop an **Architecture** ('blueprint') and a **Framework** (real code) to be used at all stages of LHCb data processing

- HLT, simulation, reconstruction, analysis

Avoid fragmentation and duplication of computing efforts

Transparent use of third-party components wherever possible

Applications are developed by customizing the **Framework**



What is a Framework?

Framework Definition [1,2]

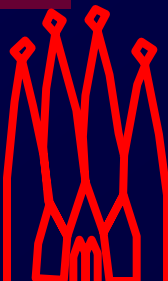
- **An architectural pattern that codifies a particular domain. It provides the suitable knobs, slots and tabs that permit clients to use and adapt to specific applications within a given range of behavior.**

In practice

- **A skeleton of an application into which developers plug in their code and provides most of the common functionality.**

[1] G. Booch, "Object Solutions", Addison-Wesley 1996

[2] E. Gamma, et al., "Design Patterns", Addison-Wesley 1995

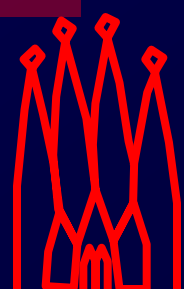
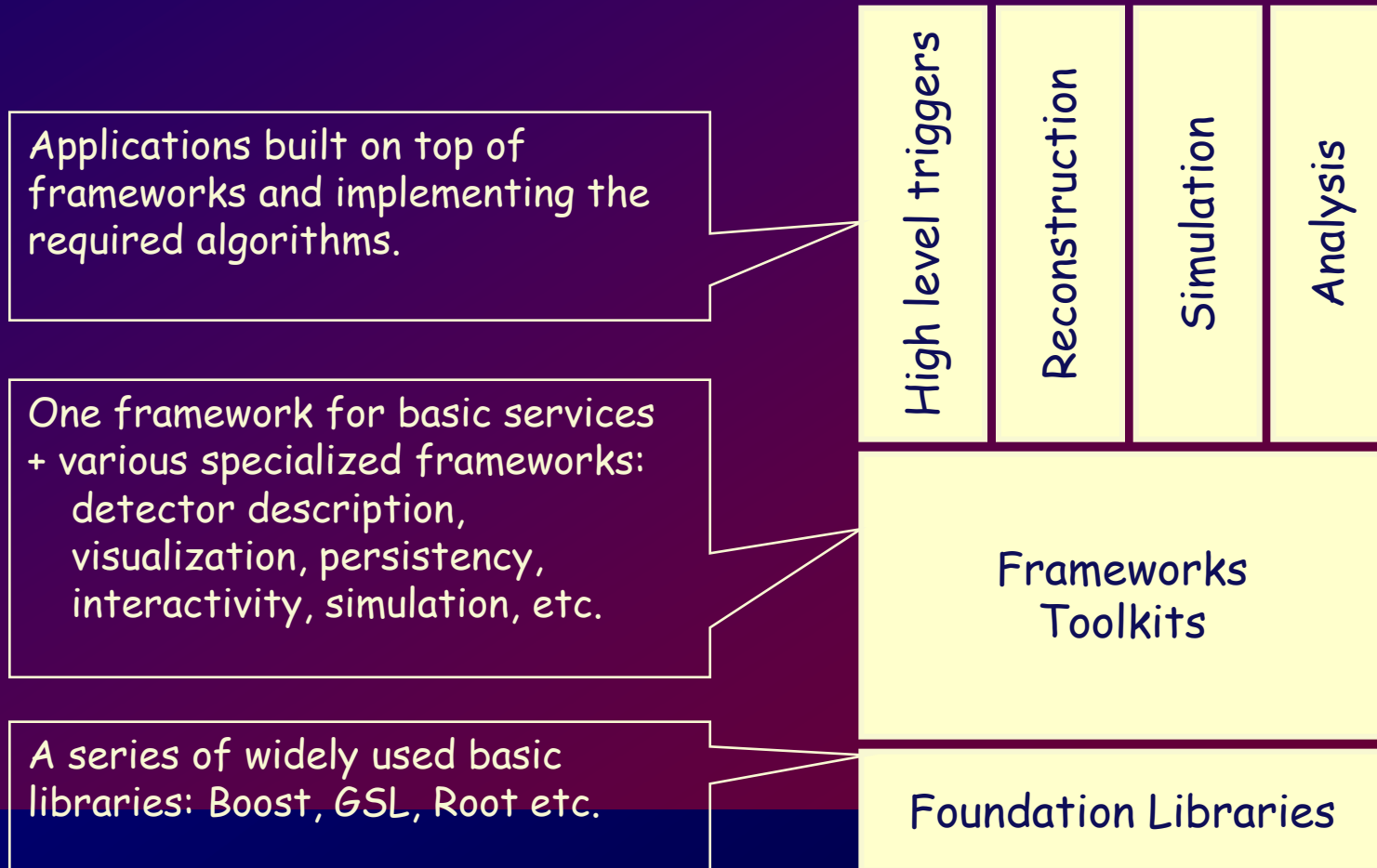


Framework Benefits

- **Common vocabulary, better specifications of what needs to be done, better understanding of the system.**
- **Low coupling between concurrent developments. Smooth integration. Organization of the development.**
- **Robustness, resilient to change (change-tolerant).**
- **Fostering code re-use**



Software Organization



Gaudi Architecture

GAUDI is an **architecture** and **framework** for event-processing applications (simulation, reconstruction, etc.)

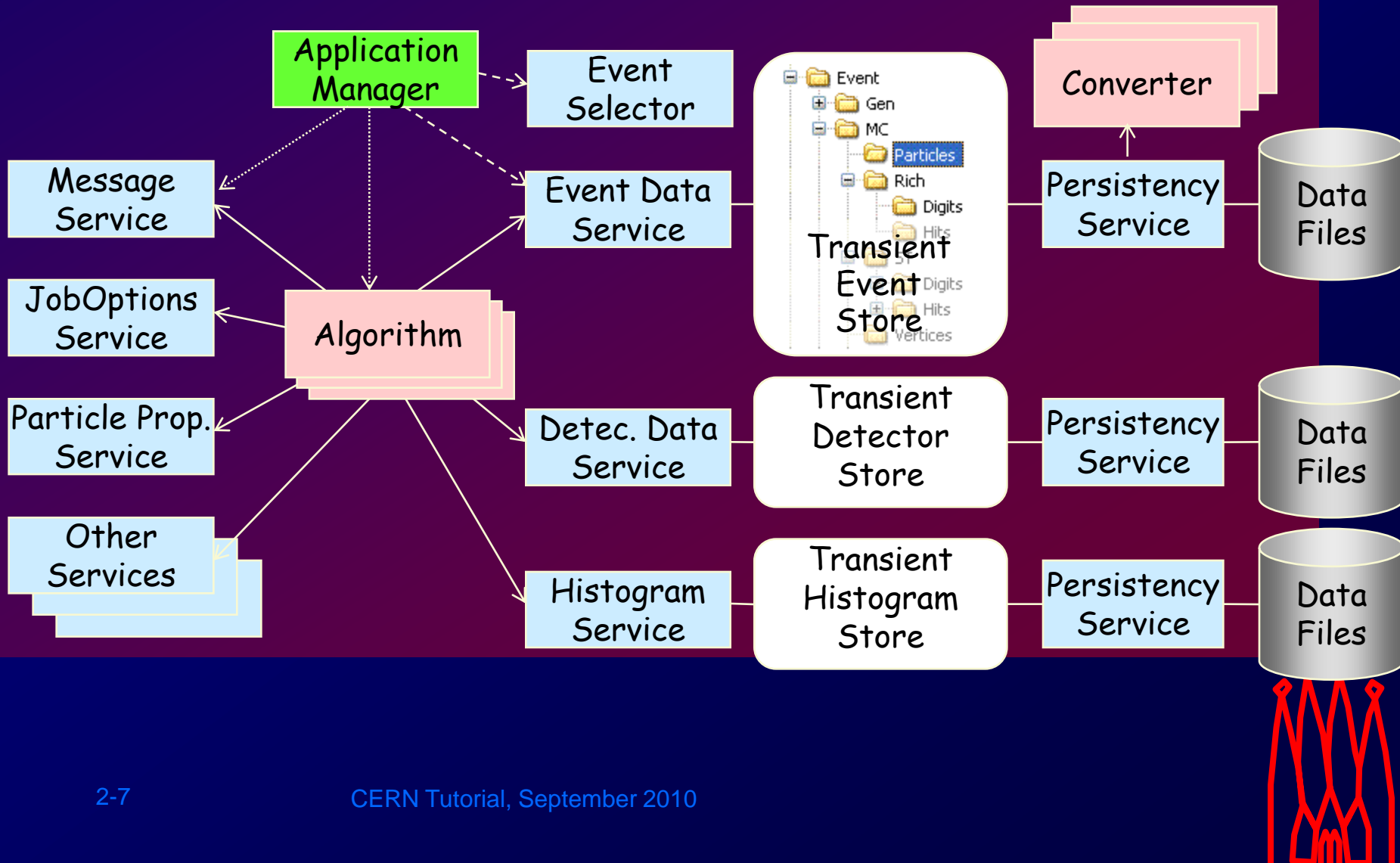
- Initially developed for LHCb, it has been adopted and extended by ATLAS and adopted by several other experiments including Fermi Space Telescope, HARP, Minerva, Daya Bay

Main **Design** Choices best illustrated by looking at the **Gaudi Object diagram**

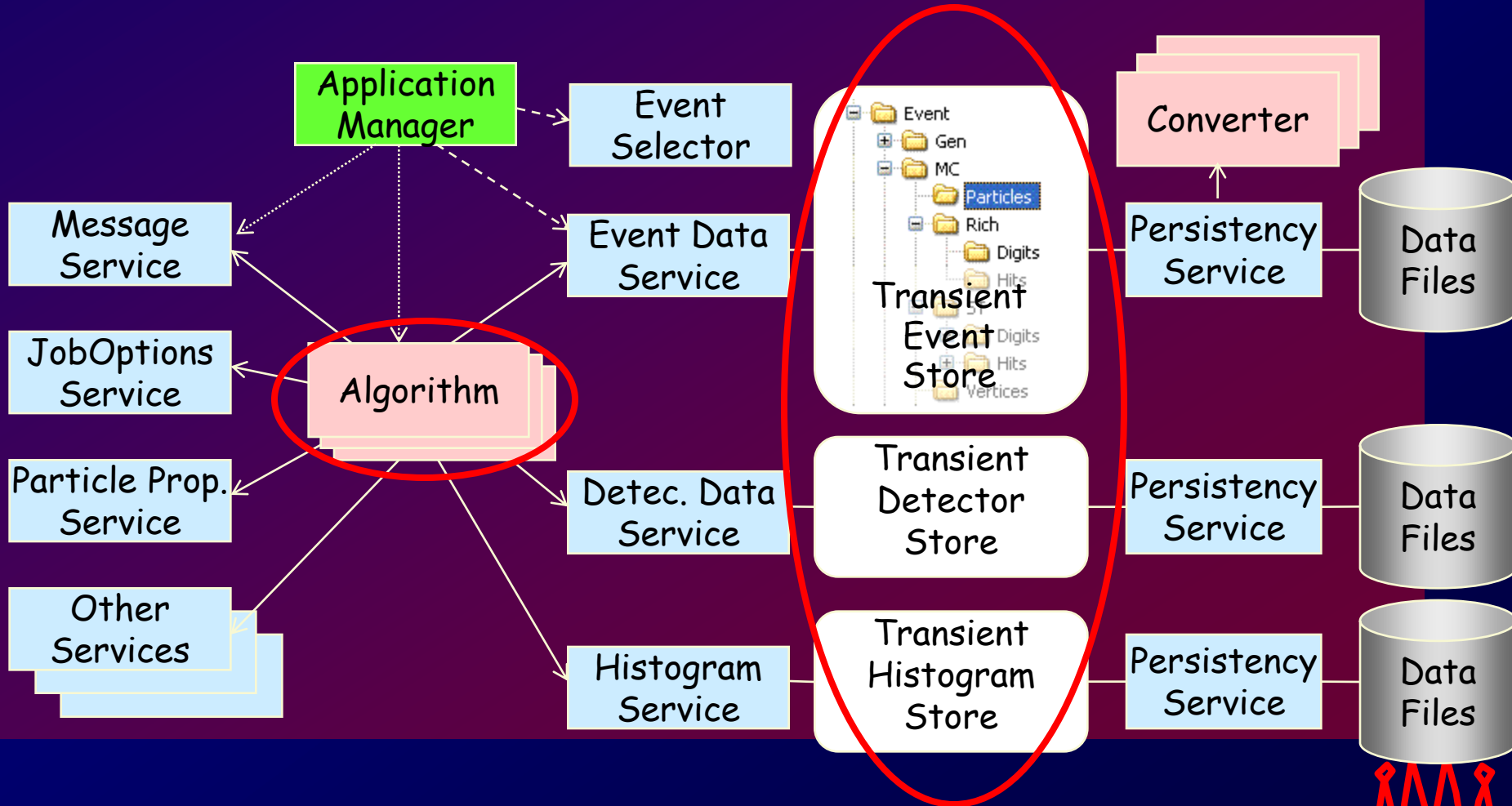
- A snapshot of the components in memory, once the job is initialized and running



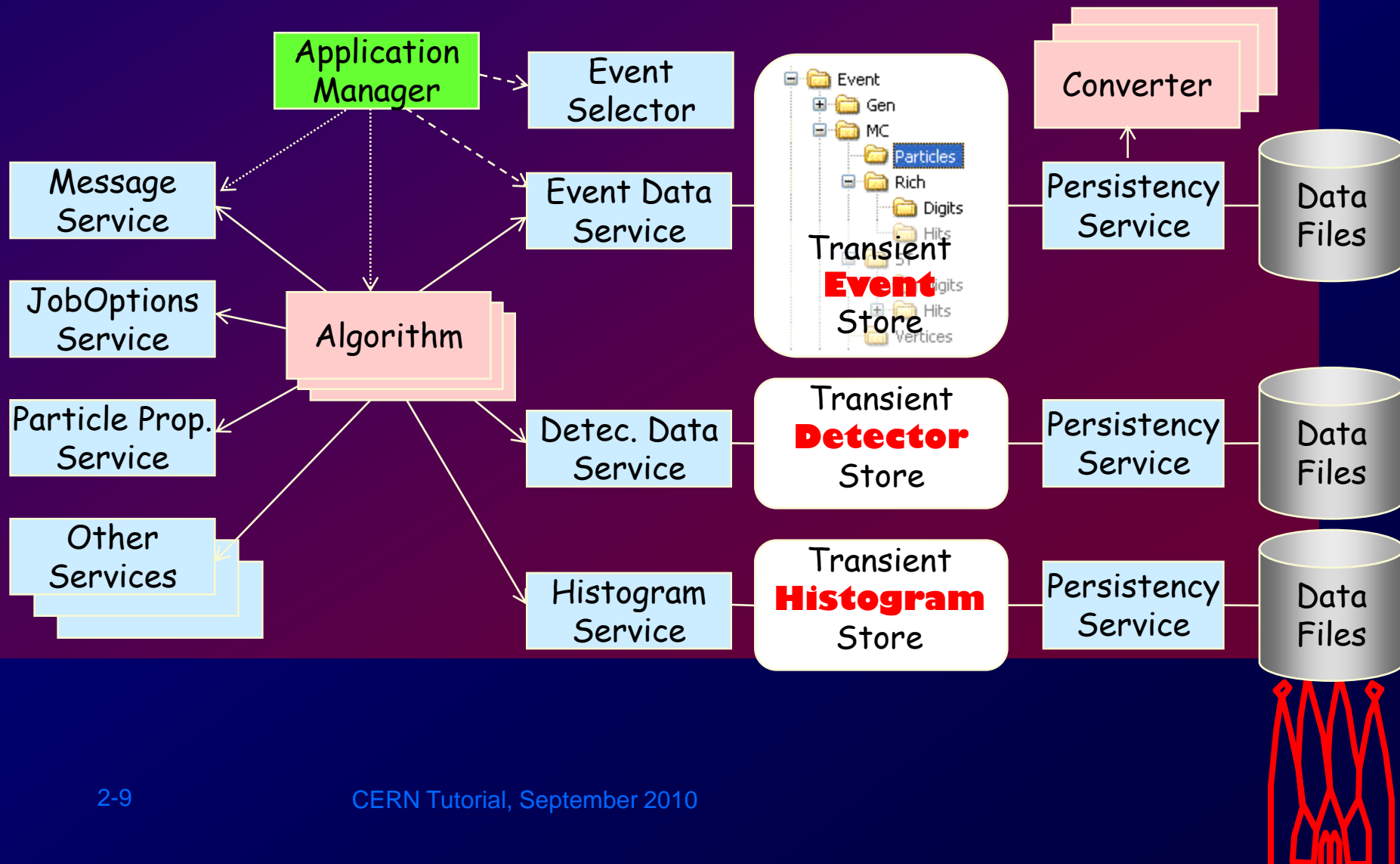
Gaudi Object Diagram



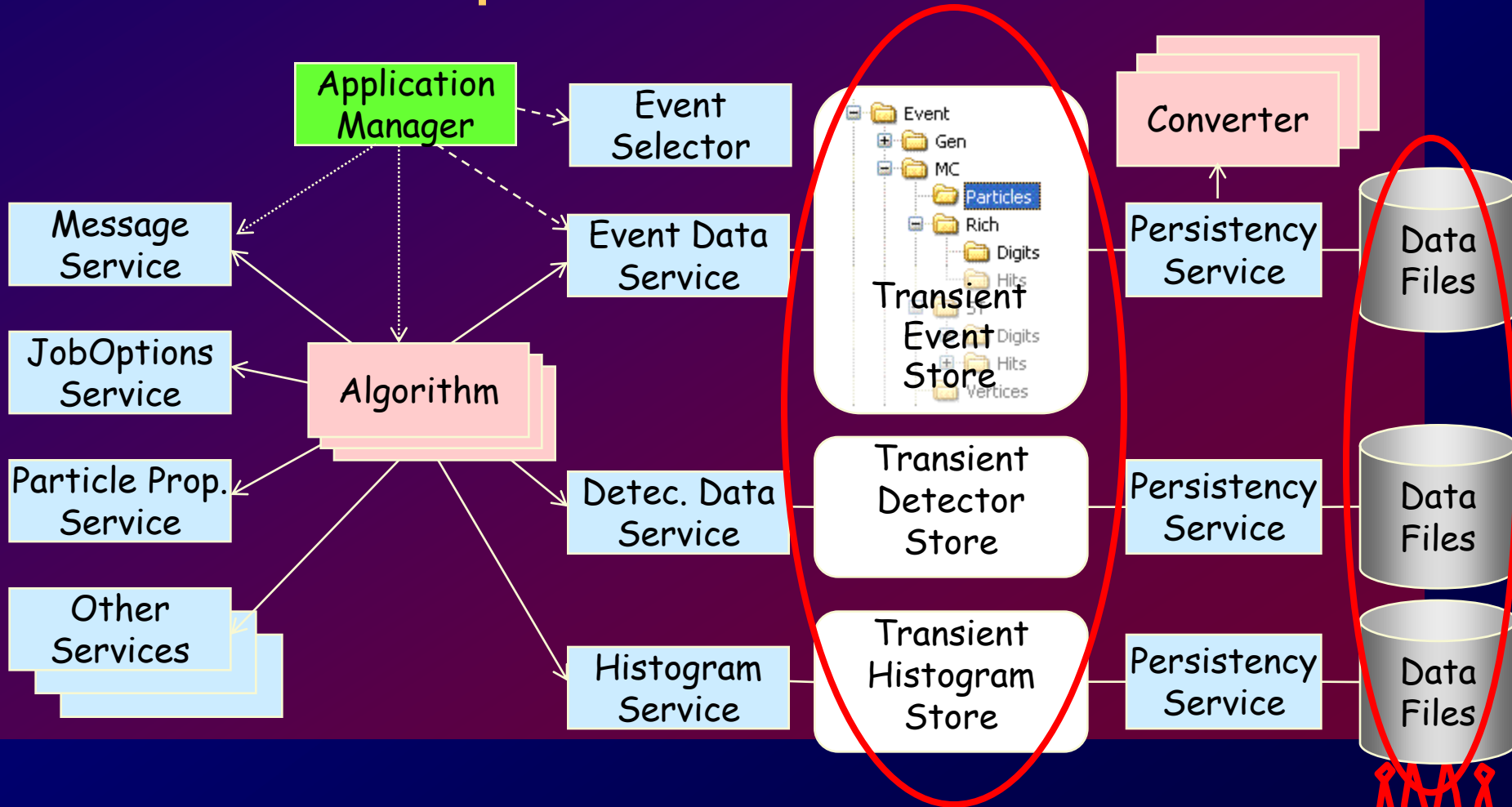
Separation between “data” and “algorithms”



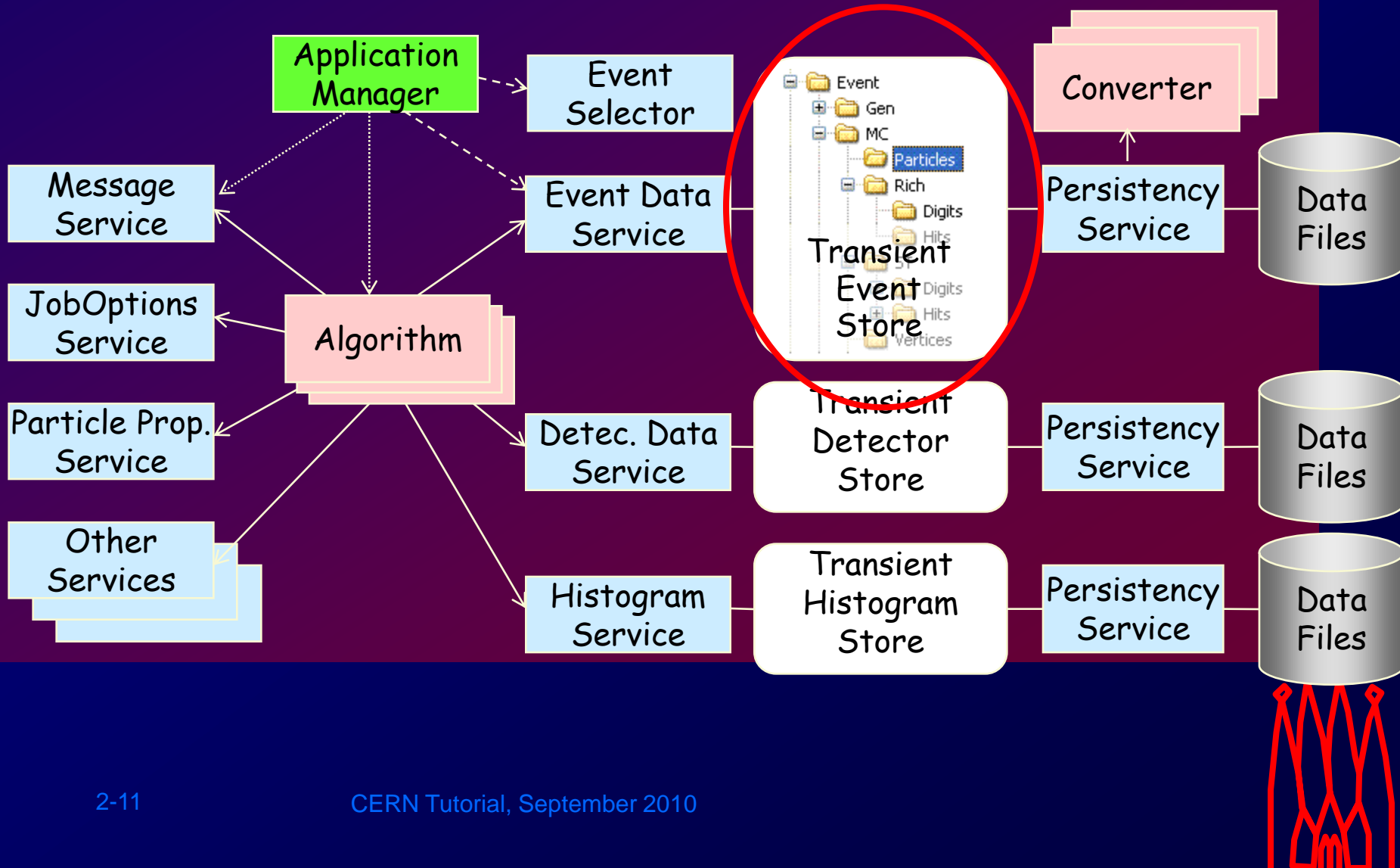
Three basic categories of data characterized by their “lifetime” in the job



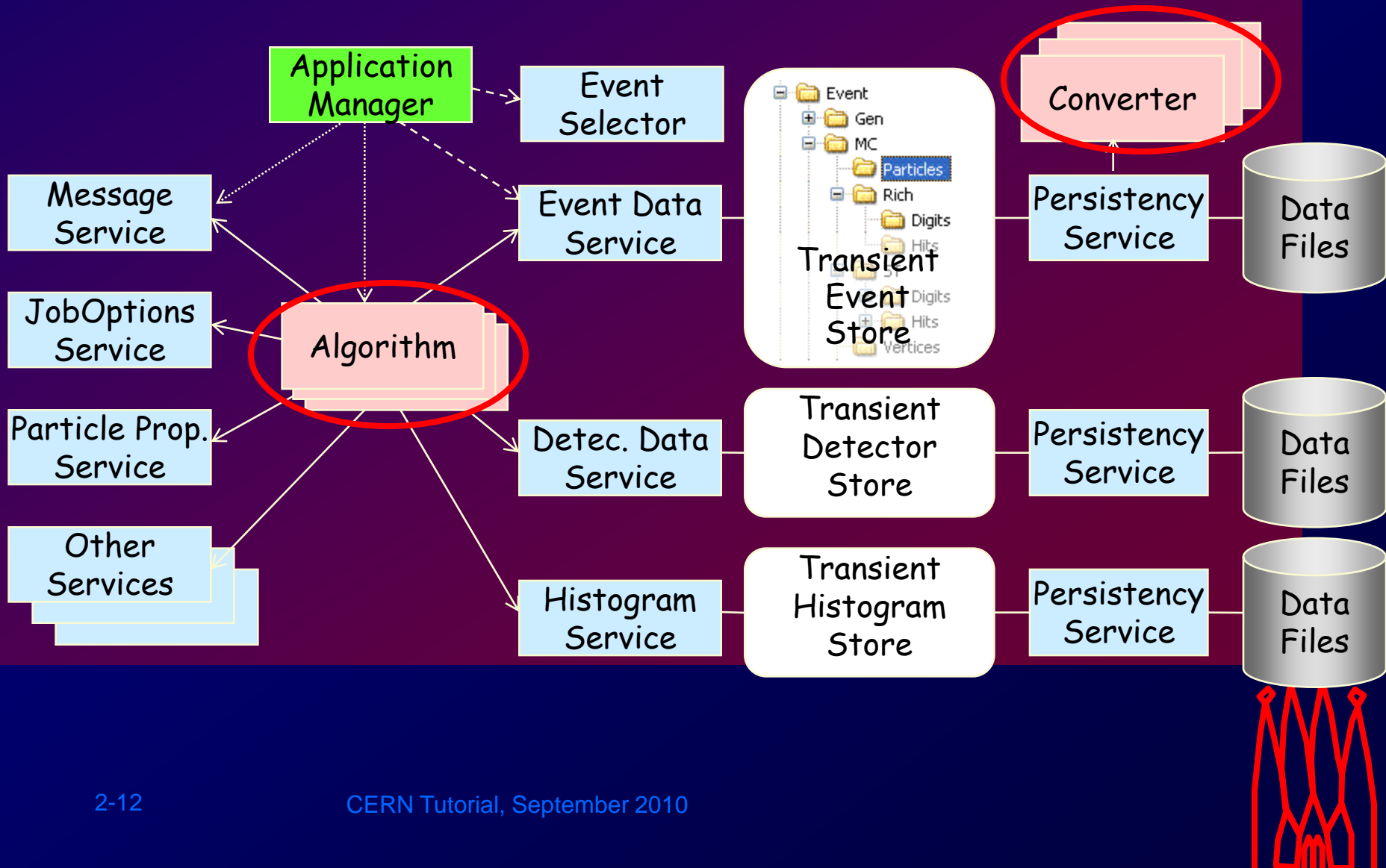
Separation between “transient” and “persistent” representations of the data



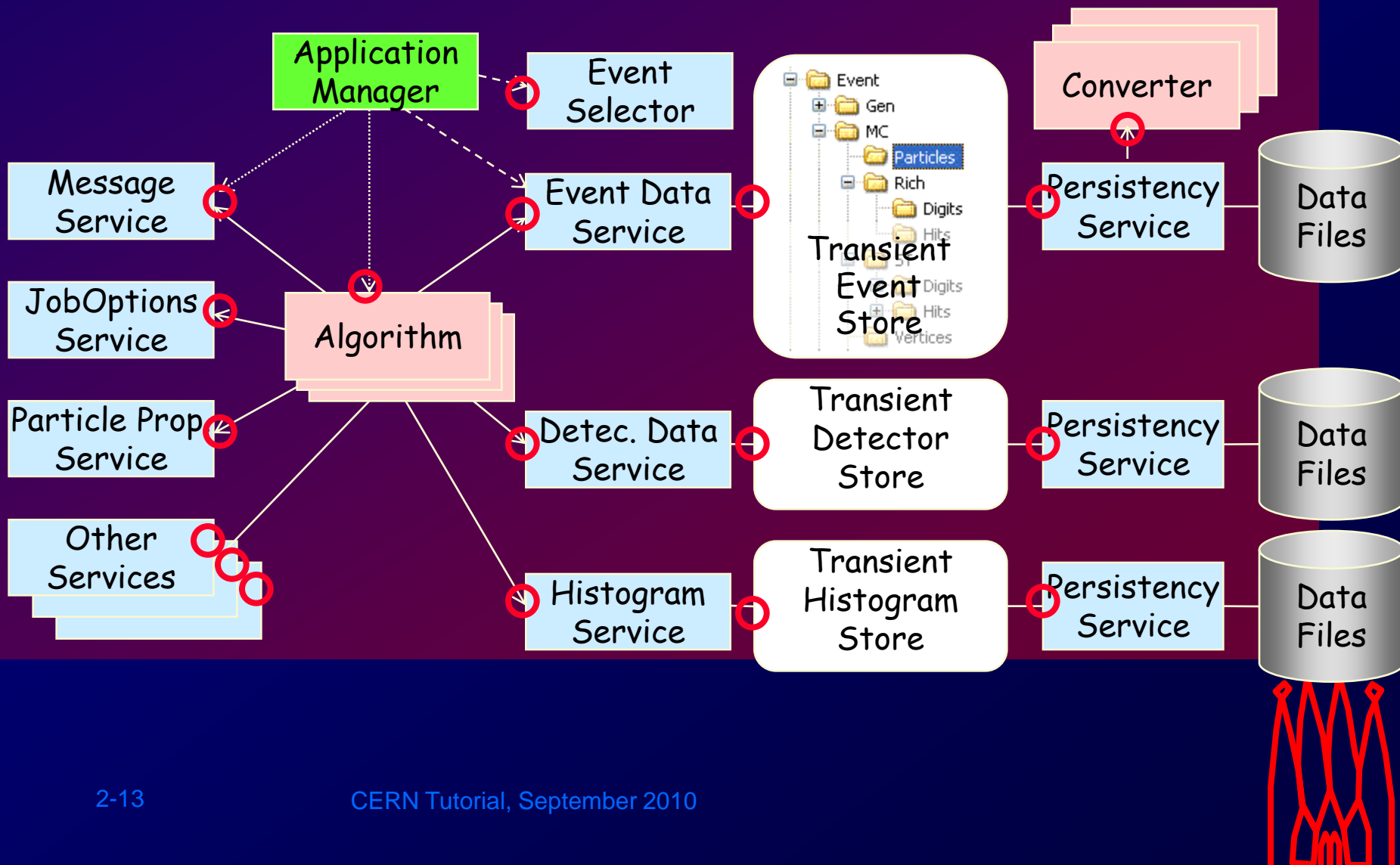
Data store-centered (“blackboard”) architectural style



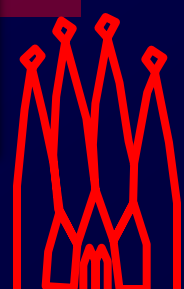
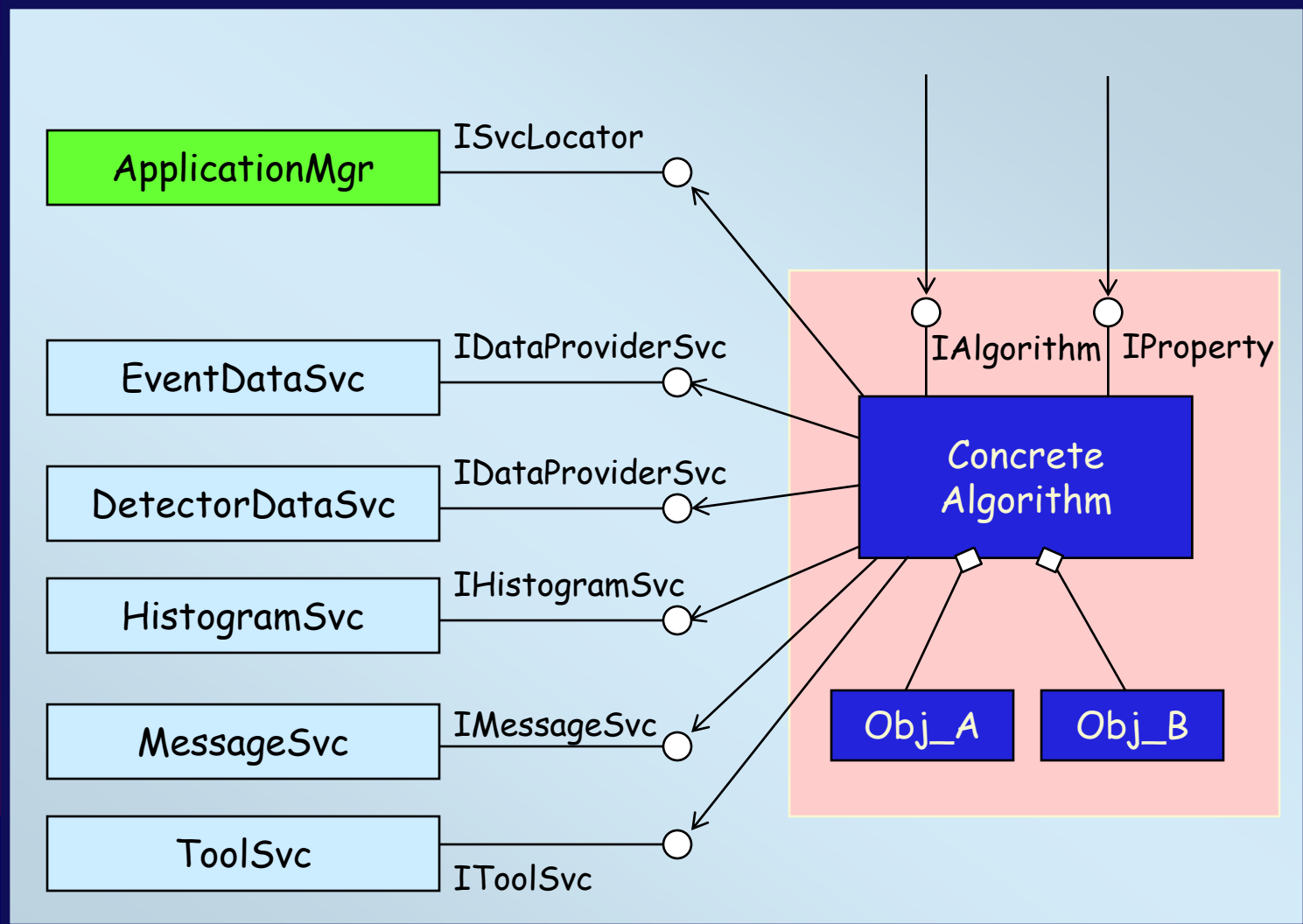
“User code” encapsulated in few specific places



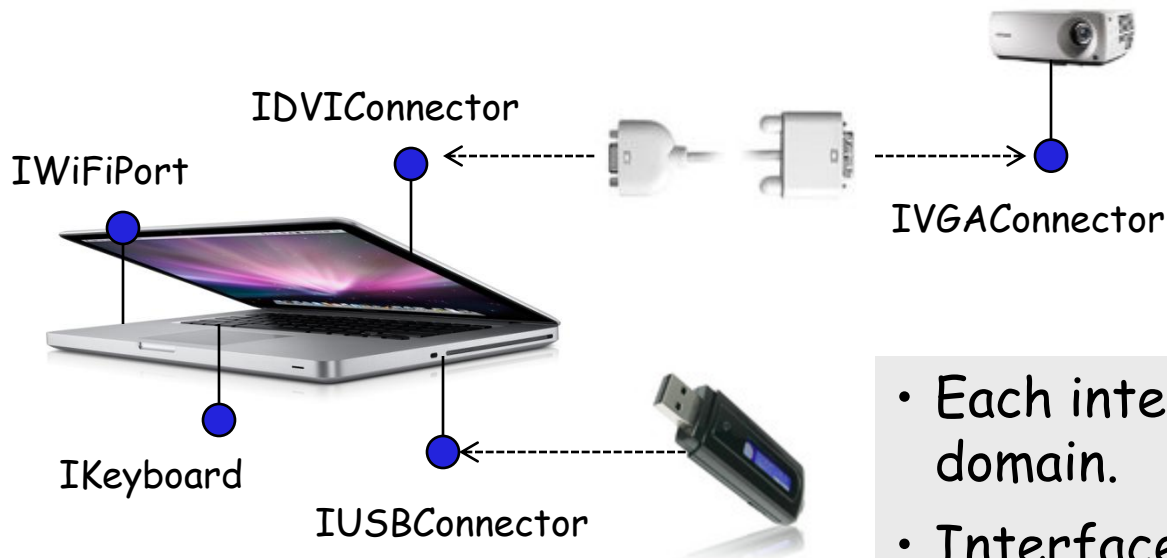
Well defined component “interfaces”



Gaudi Interface model



Laptop Interface Model

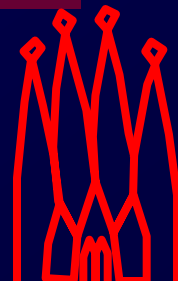


- Each interface is specialized in a domain.
- Interfaces are independent of concrete implementations.
- You can mix devices from several constructors.
- Application built by composing.
- Standardizing on the interfaces gives us big leverage.

Electrical plug interface model



Don't define too many interfaces for the same job!



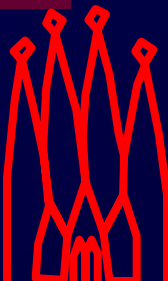
Interfaces in Practice

IMyInterface.h

```
class IMyInterface: virtual public IAlgTool {  
    virtual double doSomething( int a, double b ) = 0;  
}
```

MyDoSomethingTool.h

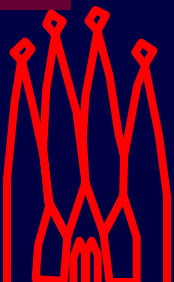
```
#include "IMyInterface.h"  
  
class MyDoSomethingTool : public GaudiTool,  
                          virtual public IMyInterface {  
    inline double doSomething( int a, double b )  
    { return b * (double)a; }  
}
```



ClientAlgorithm.cpp

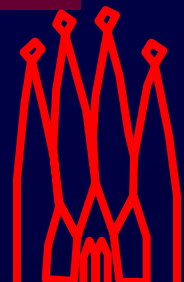
```
#include "IMyInterface.h"

ClientAlgorithm::myMethod() {
    // Declare the interface
    IMyInterface* myInterface;
    // Get the interface from somewhere
    myInterface = tool<IMyInterface>("MyDoSomethingTool");
    // Use the interface
    double result = myInterface->doSomething( 10, 100.5);
}
```



Gaudi Component Model

- **Algorithms, Converters, Services and Tools are known as *Components***
 - Self contained objects with behaviour
 - Loaded at run time from component libraries (“plugins”)
 - Interact with the framework and with each other via *Interfaces*
 - Behaviour controlled by *Properties* (“Job options”)
- **Properties**
 - Control and data parameters for Algorithms, Services and Tools

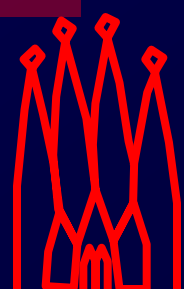
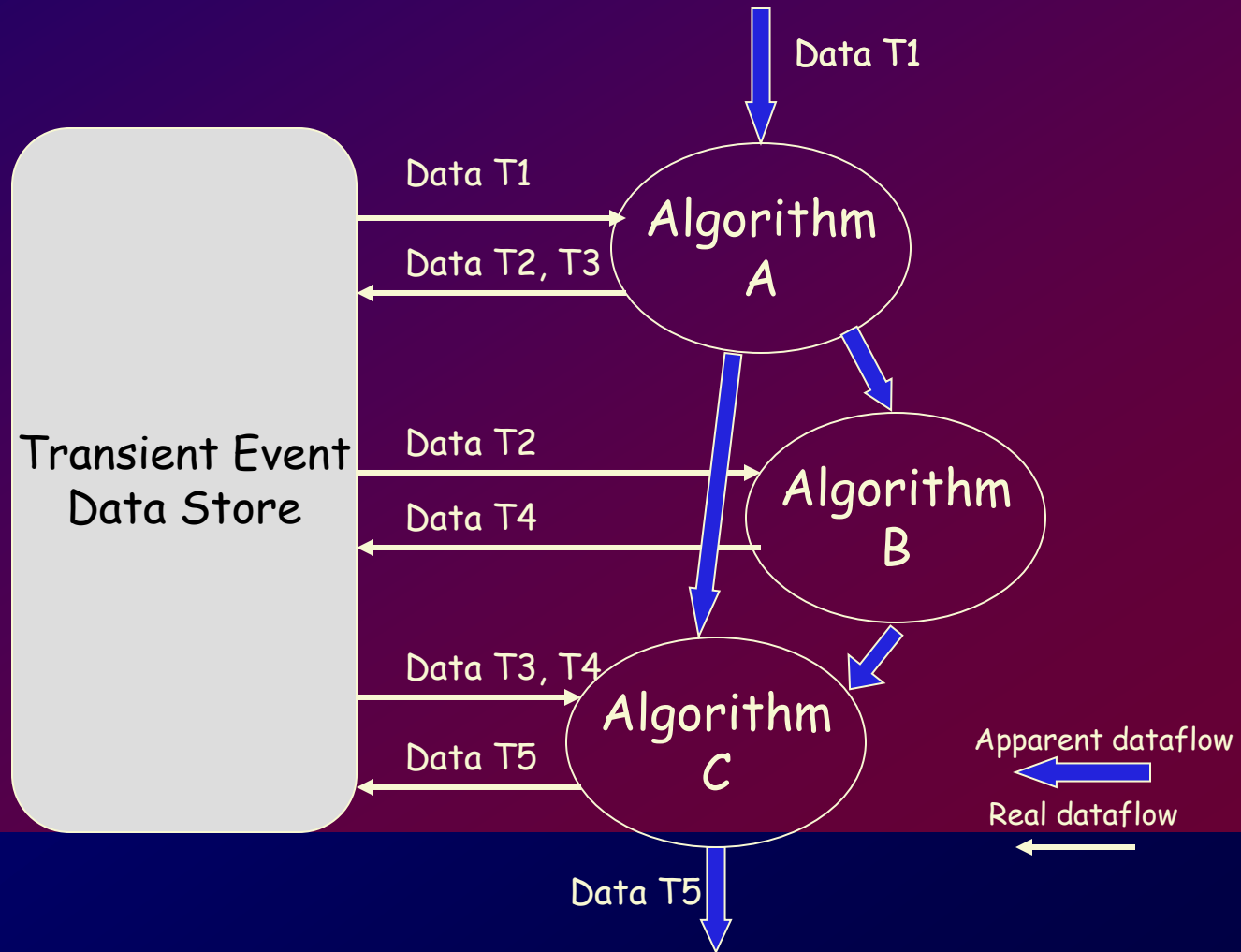


Algorithm

- **Users write Concrete Algorithms**
- **It is called once per physics event**
- **Implements three methods in addition to the constructor and destructor**
 - **initialize(), execute(), finalize()**

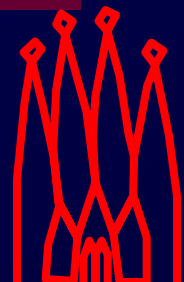


Algorithm & Transient Store



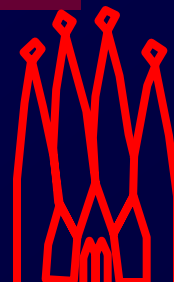
Tools

- **Algorithms only share data via TDS**
 - What about private data?
- **Tools are globally or locally available components providing algorithmic functionality**
 - Callable many times per event, through specific interface and **with arguments**
 - IBdlTool, IDistanceCalculator, IHltSummaryTool, IMassVertexFit, IProtoParticleFilter, ISTRReadoutTool, ITrackFitter....



Services

- **Globally available software components providing framework functionality**
 - **JobOptions Service, Message Service, Particle Properties Service, Event Data Service, Histogram Service, N-tuple Service, Detector Data Service, Magnetic Field Service, Random Number Service, Chrono Service, (Persistency Services), (User Interface & Visualization Services), (Geant4 Services)**



Data

- **Data Object**

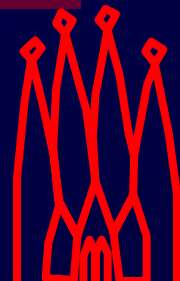
- Atomic data unit (visible and managed by transient data store)
- No algorithmic code

- **Transient Data Store**

- Central service and repository for data objects
- Manages data location, life cycle, load on demand, ...

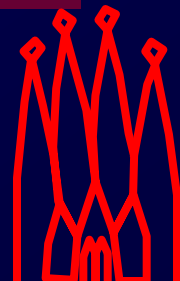
- **Data Converter**

- Provides explicit/implicit conversion from/to persistent data format to/from transient data



Gaudi Product Sheet

- **Current release**
 - v21r11 (Sep 2010)
- **Supported Platforms**
 - Scientific Linux (CERN) 5 & gcc 4.3
 - Scientific Linux (CERN) 4 & gcc 3.4
 - Windows XP & VisualC++ 7.1
 - (gcc 4.3 with OSX 10.5)
- **Web address.**
 - <http://cern.ch/proj-gaudi/>



Documentation

- **Gaudi User Guide**
 - A 220 pages document targeted to end-users
- **FAQ: Mixture of Gaudi and LHCb specific topics**
 - <https://twiki.cern.ch/twiki/bin/view/LHCb/FAQ/LHCbFAQ>
- **C++ Documentation (generated from code)**
 - **Doxygen:**
 - Uses special comments in code, e.g. Tutorial solutions
 - <http://cern.ch/proj-gaudi/releases/GAUDI/doc/html/index.html>
 - **Lbglimpse: indexed search within released code**
 - Lbglimpse <search string> <Project> <version>
 - `Lbglimpse IJobOptionsSvc Gaudi v21r11`
- **Self help mailing lists:**
 - lhcsoft-talk@cern.ch, gaudi-talk@lists.bnl.gov

