

---

# Architecture & Framework

**David R. Quarrie**

**Lawrence Berkeley National Lab**

***DRQuarrie@LBL.Gov***



# Overview

---

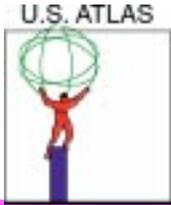
- **Architectural Task Force**
  - ◆ **Architectural Vision**
- **Architecture Team**
  - ◆ **Framework Design & Implementation**
- **Milestones**
- **Closing Remarks**



# Architecture Task Force

---

- **Established June 1999**
  - Katsuya Amako (KEK)
  - Laurent Chevalier (Saclay)
  - Andrea Dell'Acqua (CERN)
  - Fabiola Gianotti (CERN)
  - Stephen Haywood (RAL) - Chair
  - Norman McCubbin (RAL)
  - Helge Meinhard (CERN)
  - **David Quarrie (LBNL)**
  - RD Schaffer (CERN+LAL)
  - **Marjorie Shapiro (LBNL)**
  - Valerio Vercesi (INFN)
  - Torsten Akesson (ATLAS management)



# ATF - Mandate

- “... specify the global architecture of ATLAS computing in a way that provides a unified execution framework for data access, reconstruction, simulation, analysis and event display.”
- “... a database interface making ATLAS independent of database supplier.”
- “Full attention should be given to implementations already carried out in previous and upcoming experiments...”
- “A first version of the architecture document should be made available to the collaboration at the latest three months after the launch of the taskforce.”
- “The taskforce will have a composition taken from a large base in the collaboration so as to ensure that the architecture will be one with a broad support.”



# Glossary

---

- **Architecture**

- ◆ The structure of the system, comprising the components, the externally visible properties, and the relationships among them

- **Framework**

- ◆ Represents a collection of classes that provide a set of services for a particular domain
- ◆ A concrete realization of an architecture

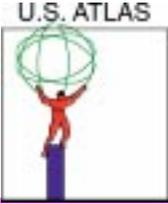
- **Component**

- ◆ A physical and replaceable part of a system that conforms to and provides the realization of a set of interfaces



# ATF - Work

- Presentations (LHCb, *B<sub>A</sub>B<sub>AR</sub>*, CDF, D0,...)
- Architectural Design
  - ◆ Two approaches to identify components, responsibilities and relationships
    - ▲ Prior experience
    - ▲ Unified Software Development Process (USDP) based approach
  - ◆ Approaches complementary
    - ▲ New insight
    - ▲ Validation of experience-based conclusions
  - ◆ Merging incomplete at termination of ATF



# USDP

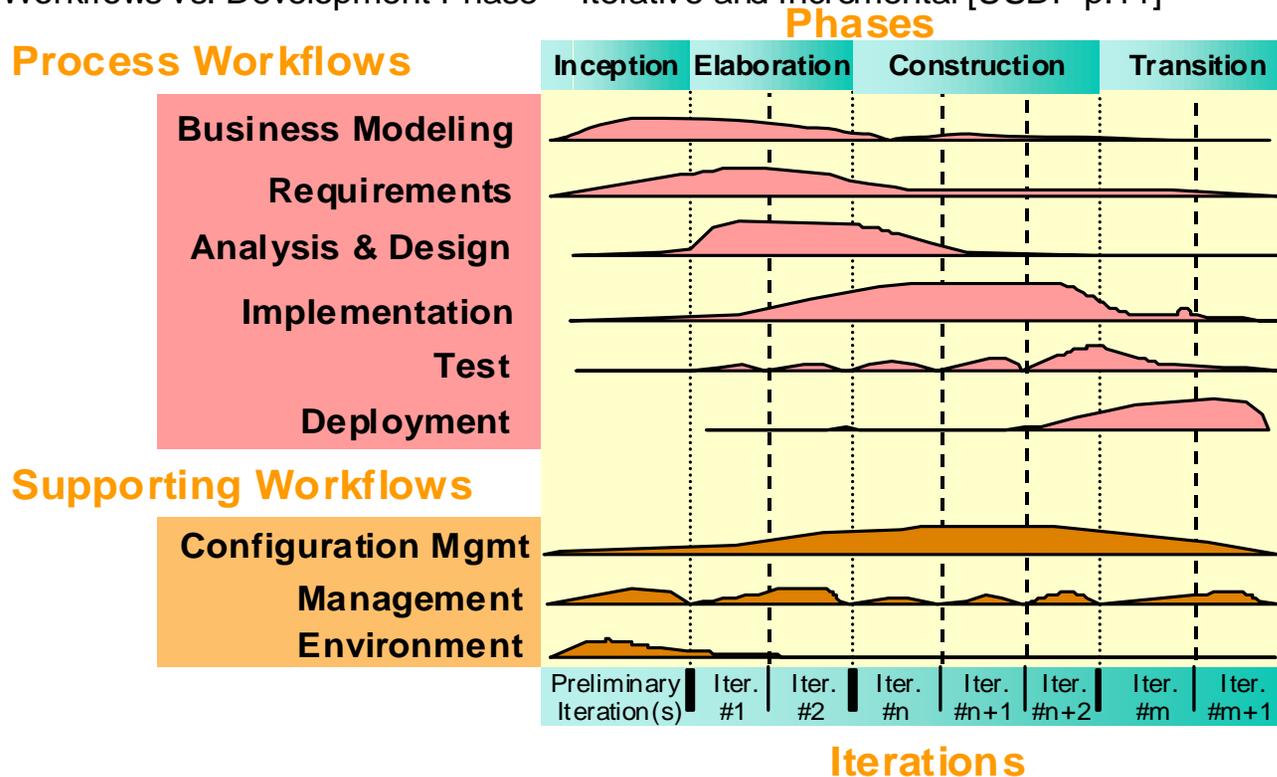
- **Unified Software Development Process**
  - ◆ **Booch, Jacobson, Rumbaugh**
- **Unified Modelling Language (UML) as notation**
- **Development is use-case driven**
- **Multiple phases**
  - ◆ **Requirements, Analysis, Design, Implementation, Testing, etc.**
- **Incremental**
- **Iterative**



# USDP Phases

## Software Development Process: USDP

- Workflows vs. Development Phase - Iterative and incremental [USDP p.11]





# Core Abstractions

- **Modules/Algorithms**
  - ◆ Computational code
- **Data Objects**
  - ◆ Module Inputs and outputs
  - ◆ Transient objects capable of being converted
- **Converters**
  - ◆ Convert data from one representation to another
    - ▲ Transient/Persistent
    - ▲ Transient/Graphical
- **Services**
  - ◆ Components that provide a support service
- **Stores**
  - ◆ Several, both transient & persistent



# ATF - Components

<i>Configuration &amp; Execution Components</i>	<i>Manager Components</i>	<i>Data Components</i>	<i>Additional Services &amp; Components</i>
<b>Framework Manager</b>	<b>Event Input</b>	<b>Event</b>	<b>User Interface</b>
<b>Application Manager</b>	<b>Event Output</b>	<b>Detector Description</b>	<b>Message Service</b>
<b>Job Options Service</b>	<b>Data Item Selector</b>	<b>Conditions Data</b>	<b>Bookkeeping</b>
	<b>Event Collection Manager</b>	<b>Statistics Data</b>	<b>History</b>
	<b>Event Merge</b>	<b>Magnetic Field</b>	<b>Particle Properties</b>
	<b>Module Interface</b>		

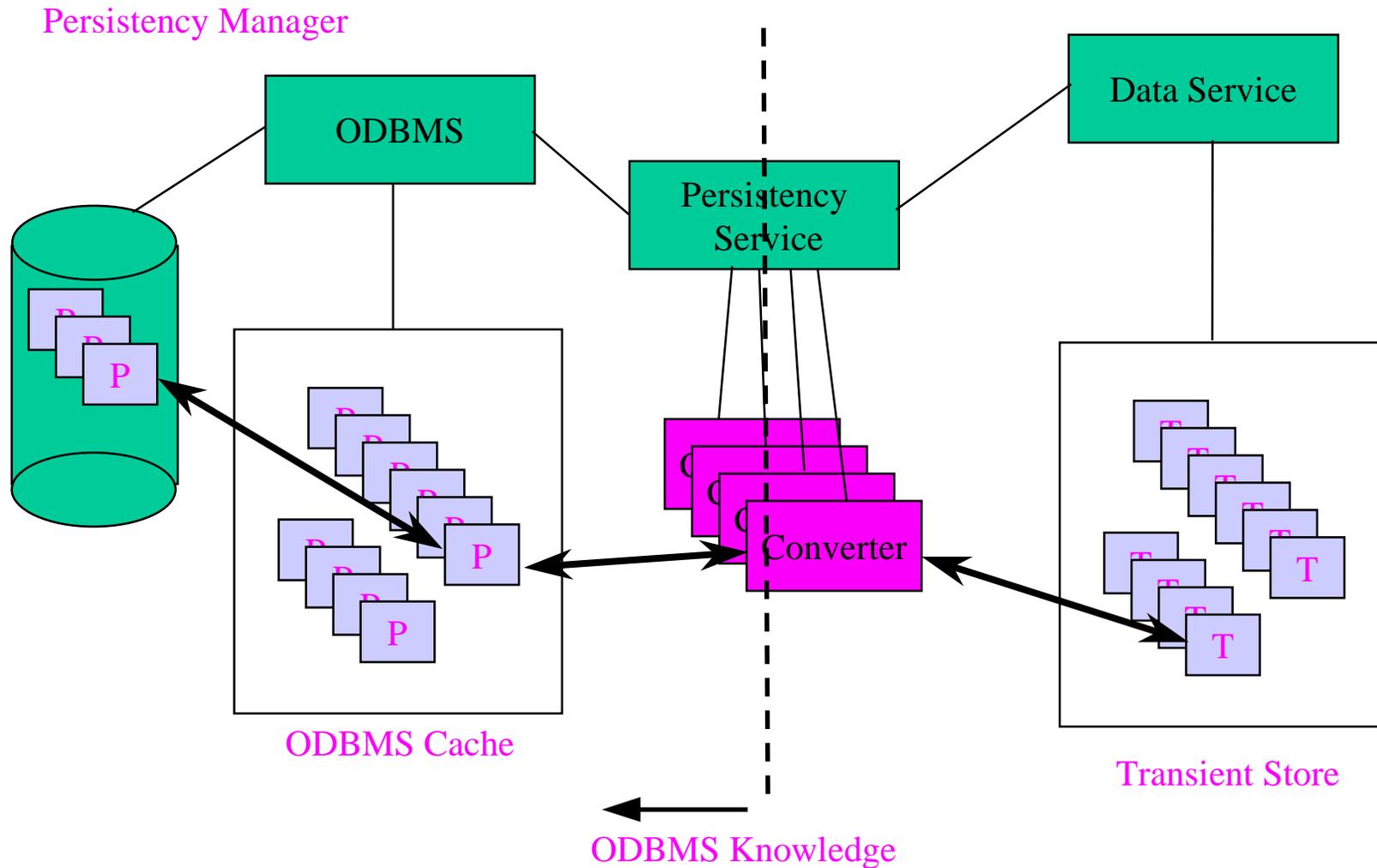


# ATF - Major Decisions

- **Object oriented paradigm**
  - ◆ C++ implementation language
  - ◆ Java foreseen
- **Separation of Data and Algorithms**
  - ◆ See later slide
- **Separation of Transient and Persistent Data**
  - ◆ Independence from persistent implementation
- **Transient Event Store as scratchpad**
  - ◆ Owner of intermediate results
  - ◆ Communication between Modules/Algorithms
  - ◆ Source of data that can be made persistent at end of processing



# Transient/Persistent Separation





# Data/Algorithm Separation

- **Not functional decomposition**
- **Framework schedules computational tasks for objects exhibiting the algorithm interface (modules)**
  - ◆ **Raises issue of granularity**
  - ◆ **Provide guidance for algorithm developers**
- **Data objects can be complex and have a significant computational behavior**
  - ◆ **Modules can delegate some processing to data objects**
  - ◆ **Capable of being converted to a persistent representation**
- **Data/Algorithm lifetimes are different**
  - ◆ **Data lifetime is the event**
  - ◆ **Module lifetime is the job**



# Architecture Team

- **Detailed Design and Implementation**
  - ◆ **Led by Chief Architect**
- **Three USA Members**
  - ◆ **David Quarrie (LBNL)**
    - ▲ **Acting as interim team leader**
  - ◆ **Craig Tull (LBNL)**
  - ◆ **Paulo Calafiura (LBNL)**
- **One other known Member**
  - ◆ **Katsuya Amako (KEK)**
- **Others still being sought by Computing Coordinator**
- **Goal is ~6 people**



# A-Team - Work

---

- **Core team augmented**
  - ◆ Database
  - ◆ Graphics
  - ◆ Reconstruction
  - ◆ Simulation
  - ◆ Physics Analysis
  - ◆ ...
- **Crucial to develop good working relationships outside the team**
- **Formal relationship to other computing groups still being understood**
  - ◆ **Very useful feedback from John Harvey**



# A-Team - Approach

- Not waiting for rest of team to be announced
- Multi-pronged approach
  - ◆ Understand present Computing Infrastructure
  - ◆ Preliminary task list & milestones
  - ◆ Establish contact with software groups (reconstruction, *etc.*)
  - ◆ Establish short term working meetings *etc.*
  - ◆ May prototype based on GAUDI
    - ▲ See next slide
  - ◆ USDP work
    - ▲ Katsuya augmented by Chris Day (LBNL)
      - Chris as software process librarian
        - Experienced in USDP and Rational Rose



# GAUDI

- **LHCb Architecture**
  - ◆ **John Harvey, Pere Mato et al.**
- **Embodies a coherent vision**
- **Clear distinction between abstractions and implementations**
- **Identifies many of the same components as the ATF**
  - ◆ **Not really surprising**
    - ▲ **Mutual incorporation of ideas and experience**
- **In third release iteration**



## GAUDI vs BABAR/CDF Framework

- Embodies a more coherent vision
- Better use of abstractions
- Capable of using *BABAR/CDF* components
  - ◆ *E.g. BABAR ProxyDict as transient event store*
- Better capable of being used in distributed environment
- Support for multiple scripting languages
- Suitable for Java
- Maturity vs. potential
  - ◆ *Believe GAUDI has more potential*



# Control Framework Major Milestones

- **May 2000 Prototype**
  - ◆ **Based on GAUDI**
- **Jun 2000 Alpha Release Design Review**
- **Sep 2000 Alpha Release**
  - ◆ **Incorporate USDP feedback**
- **Mar 2001 Freeze Full Function Release functionality**
- **Jul 2001 Full Function Release Design Review**
- **Oct 2001 Full Function Release**
- **Apr 2002 Freeze Production V1 functionality**
  - ◆ **Distributed (support computational grid)**
- ***etc.***
- **Expect minor releases at ~3-4 month intervals**



# May 2000 Prototype

- Major concern is credibility
- We can't afford not to deliver something
- Crucial to gain acceptance from users
- Propose to provide something close to PASO shell but with much better functionality and potential for extensibility
  - ◆ Easy to incorporate existing development
  - ◆ Existing user community
  - ◆ Defuse further development on PASO
    - ▲ Involve PASO developers with future development in the context of the framework *etc.*



# May 2000 Prototype

- **Proposal is to base on GAUDI**
  - ◆ **Basic transient event store**
    - ▲ Evaluating *BABAR*/GAUDI/CDF versions now
    - ▲ Incorporate existing transient event model (Schaffer et al.)
      - Recognize that this needs to be replaced – not scalable
    - ▲ Read TDR simulation data
    - ▲ Allows existing ATLAS reconstruction modules to be incorporated with only minor changes
  - ◆ **Extend GAUDI**
    - ▲ Sequencing Service
    - ▲ Commands
    - ▲ Command Interpreter instead of job options



# May 2000 Functionality

- Support for TDR simulation data
- Existing XML Detector Description Model
- Existing ATLAS visualization
- Limited ability for persistent output
- Sequencing of multiple algorithms/modules
  - ◆ Follow *BABAR/CDF* model of multiple paths comprising multiple modules capable of filtering
    - ▲ Hypothesis-based processing
      - Each path corresponds to a physics signal
        - Succeeds if event meets filter criteria
- Dynamic loading of user modules



# Parallel Development

- **Going for a GAUDI-based May 2000 prototype doesn't mean simple adoption**
  - ◆ **ATLAS-specific implementations feasible and expected**
- **Parallel USDP based development**
  - ◆ **Provide new insights**
  - ◆ **Validate & catalog experience-based conclusions**
- **Merge in Sep 2000 release**
- **Feedback to GAUDI team**
  - ◆ **ATLAS "personality" to GAUDI developed**



# Future Releases

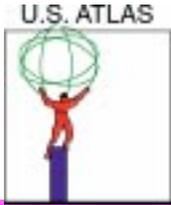
---

- **September 2000**
  - ◆ Merged USDP/GAUDI
  - ◆ Geant3 Simulation integration
  - ◆ Wrapped FORTRAN
  - ◆ Event Model
  - ◆ Run-time configuration
  - ◆ Limited Physics Analysis output – Histograms/NTuples
- **October 2001**
  - ◆ Full Database integration
  - ◆ Geant4 Simulation integration
  - ◆ Physics Analysis Tool integration
  - ◆ Visualization
  - ◆ Statistics & Monitoring tools
  - ◆ Bookkeeping



# GAUDI Collaboration

- **Development acceleration**
  - ◆ Reuse of ideas, designs, code, *etc.*
- **CERN leverage**
  - ◆ **GEANT4 integration?**
- **Not all collaborations have been successful**
  - ◆ **I don't think this will be a problem**
    - ▲ **Common abstractions, different implementations feasible**
    - ▲ **People involved have known each other for many years**
  - ◆ **We have necessary experience if need be**
- **Stress need for a rapid prototype that minimizes future upheaval for developers**
  - ◆ **Try to get interfaces stable as quickly as possible**



# Architecture/Framework Personnel

- **Architecture & USDP Support**
  - ◆ David Quarrie (LBNL – 50%) [Architecture team]
  - ◆ Chris Day (LBNL – 66%)
- **Framework & Support**
  - ◆ Paulo Calafiura (LBNL - 50%) [Architecture team]
  - ◆ Craig Tull (LBNL - 100%) [Architecture team]
  - ◆ Charles Leggett (LBNL – 50%)
  - ◆ John Milford (LBNL – 50%)
  - ◆ A.N. Other (LBNL – 66%)
- **FTE numbers above are for FY00**
- **Good ties to other US-ATLAS personnel**
  - ◆ David Malon
  - ◆ Torre Wenaus, Sriniraj Rajagopalan
  - ◆ *etc.*



# Closing Remarks

- **Many changes in last 9 months**
  - ◆ **ATLAS Computing reorganization**
- **Architectural vision being established**
  - ◆ **Architecture Task Force**
- **Design/Implementation teams being put in place**
  - ◆ **Architecture Team**
- **US-ATLAS playing leading role**
  - ◆ **Architecture**
  - ◆ **Framework**
  - ◆ **Database**
- **May 2000 prototype is both crucial and feasible**
  - ◆ **Collaboration with GAUDI team**
  - ◆ **Basis of ATLAS-specific control framework**