The STAR Experiment

The STAR experiment has migrated its FORTran-era geometry model, developed over more than a decade of operation, to an Abstract Geometry Modeling Language (AgML). By decoupling the description of the model from the underlying software framework, we are able to provide a consistent single-source geometry for both our ROOT-based reconstruction codes and our legacy FORTran simulation package. We have been able to port the geometry model with little impact on ongoing operations. The geometry model implemented in AgML reproduces the material budgets of the original geometry for most of the configurations in which the STAR experiment has run, and we can demonstrate consistency in event reconstruction between the two versions. By adopting this approach, we have been able to preserve the description contained within our original geometry files. This means that the transition from our legacy codes to the new framework was achieved completely by the core software team, without significant demands placed on the time of detector experts who have moved on from software development and are engaged in running the experiment and analyzing data.

AgML provides a rich syntax geared towards the rapid development of detector geometries, and is supported by a C++ library which steers the creation of the concrete geometry model. The interface to the steering code is specified by an abstract base class, enabling new geometry implementations to be created easily. Thus, AgML will allow us to seamlessly migrate to new technologies in the coming decade as the STAR program draws to a close and evolves into eSTAR.

An outline of the migration process from the legacy FORTran geometry model to the AgML-based geometry is shown in Fig. 1. The STAR geometry was originally implemented using the Advanced Geant Interface [1] (AgSTAR) framework. AgSTAR used the MORTran preprocessor to extend the FORTran programming language with geometry keywords, providing a high-level interface with the GEANT 3 [2] library, and C-like syntax for flow control.

The AgML framework is based on XML. The language specification includes markup elements for geometry definition, flow control, looping, variable declaration and data structures. The AgML (XML) parser is essentially a sophisticated pre-processor, transforming recognized markup elements into the target code specified by user-defined backends. Expressions in AgML are exported directly to the target language.

AgML modules were automatically created from the original AgSTAR sources using an AgML backend and the common syntax handler.

AgML provides physicists the capability to rapidly integrate new tracking detectors into the STAR software stack and to quickly begin studying detector performance in a realistic, consistent and flexible simulation and reconstruction environment.

From AgSTAR to AgML

The Abstract Geometry Modeling Language was developed to provide a path forward, automating the process of translation and providing a level of abstraction which will streamline the process of integrating future technologies as they emerge.

Outlook and Path Forward

- STAR has evolved dramatically over more than a decade of operation, but so has the technology employed in the field
  - FORTran has become obsolete, MORTran essentially dead
  - GEANT 3 is no longer being developed, and Geant 4 has reached production-quality maturity
  - ROOT/TGeo provides a path to migrate to Geant 4
- The geometry models in simulation and reconstruction had diverged, with reconstruction using a custom model
  - Updates were not always consistently applied to both
  - Overly simplistic reconstruction geometry not sufficiently accurate, and incapable of supporting new detectors
- Demonstrated a clear need to reach a common framework

The STAR experiment has evolved significantly over more than a decade of operation.

- A new tracker is being developed for STAR: Stv
  - Nearing completion it will utilize the ROOT/TGeo geometry model provided by AgML
- New detectors are being developed to support the future eSTAR program
- Geometries developed in AgML are maintainable and reconstruction geometries allows rapid integration into the STAR analysis chain, simplifying R&D efforts
- AgML provides physicists the capability to rapidly integrate new tracking detectors into the STAR software stack and to quickly begin studying detector performance in a realistic, consistent and flexible simulation and reconstruction environment.

References: