Sonat Sen is the lead developer for the Pronghorn code that models thermal-fluid conditions within a nuclear reactor, including how fast coolant is flowing, as well as the type, temperature and amount of coolant in the system.

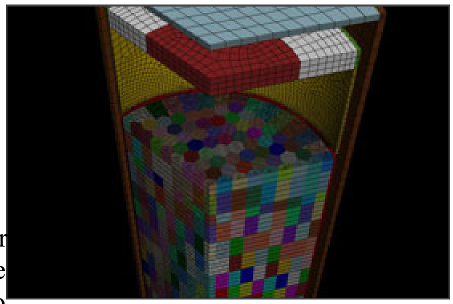
Into the MOOSE Herd: A Look at the Pronghorn Code for Nuclear Modeling

By Casey O'Donnell, *INL Nuclear Science & Technology intern*

There's a pack of animals overtaking Idaho National Laboratory.

Well, animal-nicknamed nuclear models. From Sparrow to Buffalo, and Falcon to Rattlesnake, these critter-titled codes are getting a lot of attention in the nuclear field for their many capabilities. Together and individually, they can provide information on a range of conditions and materials within a nuclear reactor. To date, there are almost 30 of them.

Sonat Sen, the current lead developer for the Pronghorn code, explained that one of the most important characteristics of these codes is their ease of use. MOOSE (the Multiphysics Object-Oriented Simulation Environment), the framework from which all of these codes draw their structure, is designed to allow users with little expertise in the fields of coding and numerical methods to run difficult simulations. In addition, MOOSE facilitates the transfer of information between applications codes that are part of the "herd."



The Pronghorn code gives information on fuel temperature, which can help engineers improve the safety and economics of nuclear reactors.

"To use one of the MOOSE-based codes, you need to know the variables for your specific test (for example, what type of fuel is in the reactor) and have a solid understanding of the physics behind the test," Sen said. "But you don't have to program any of the numerical computations. The code will do that for you."

Each code using the MOOSE framework is designed to model a specific aspect of nuclear technology. "If you think of MOOSE like a forest, the animals live in the same forest and use its resources," Sen said. "But they're all different animals. Each code has its own unique role."

The Pronghorn code that Sen develops models thermal-fluid conditions within a nuclear reactor. These conditions include how fast the coolant is flowing, as well as the type, temperature and amount of coolant in the system. When Sen started with Pronghorn, the code wasn't working as reliably or stably as desired. He re-defined the equation system, coded it into the MOOSE framework, and got the 3-D thermal-fluid simulation to work with high reliability.

Did you know?

There are now nearly 30 MOOSE-based applications in various stages of development. Developers are naming these applications for indigenous Idaho animals, but are not trying to devise a meaningful acronym for each new modeling code.

In order to model its specific set of nuclear phenomena, each MOOSE-based code relies on a set of "kernels," or physics concepts, Sen explained. Pronghorn, as a thermal-fluid model, is made of kernels that deal with temperature exchange and fluid flow. Examples include convection (heat transfer by motion of a liquid or gas) and conduction (heat transfer through matter from one particle to another), among other topics. These kernels consist of solvers for the specific equations that capture the physics involved in the problem.

Primarily, Pronghorn provides information about the ability of different coolants to remove heat from nuclear fuel under different reactor conditions. As a result, the code also gives information on fuel temperature. This information can help engineers improve the safety and economics of nuclear reactors.

"The amount of electrical power a nuclear plant can produce is directly dependent on the temperature and amount of cooling," Sen explained. "The plant can't operate at a higher power than the level the coolant can accommodate to maintain safe fuel temperatures."

Sen's most recent work on the Pronghorn code centered on improving the capabilities of the program in an effort to model the OECD MHTGR-350 benchmark. Benchmarks are standards based on data from real-world reactors that codes can be tested against. This particular benchmark is one of the most recent standards released by the Organization for Economic Cooperation and

Development. Nuclear code developers can use this data to increase the accuracy of their programs. Improvements such as these further advance the usefulness of codes like those in the MOOSE herd.

"With MOOSE-based codes like Pronghorn, we don't have to reinvent the wheel by coding solutions to equations that have been solved countless times," Sen said. "We can approach a new system, determine what physical phenomena need to be represented, and get a simulation running in a relatively short time."

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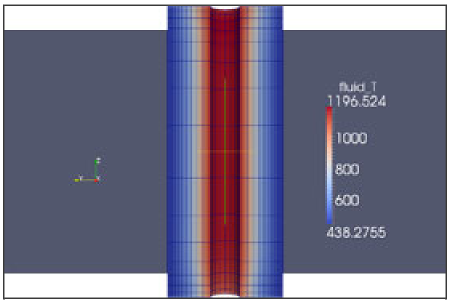

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