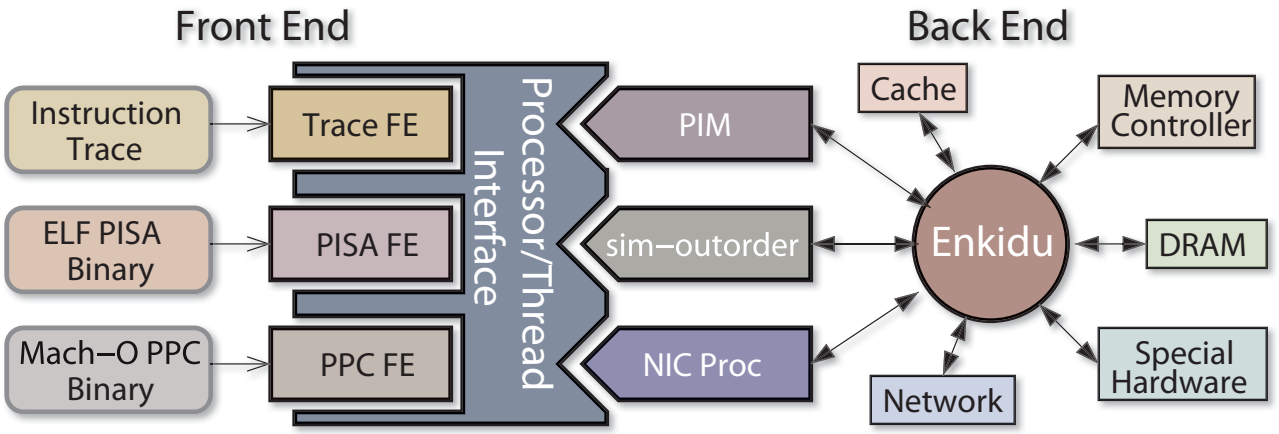

Figure 1: To encourage flexibility, the SST is comprised of "front end" modules which simulate software execution and "back end" modules which model hardware components.

The Structural Simulation Toolkit: Designing the Next Generation of Computers and Networks

Toolkit identified bottlenecks in Red Storm network and will help design more efficient networks for future supercomputers.

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High performance computer modeling and simulation is a foundational capability that underlies much of Sandia's core missions. The growing technical complexity of this work requires computers of immense power and sophistication. It is becoming increasingly difficult, however, for traditional computer architectures to grow with these challenging demands, requiring us to find new ways of organizing processors, memory systems, and networks. To guide the design and construction of the next generation of supercomputers, Sandia has developed the Structural Simulation Toolkit (SST). The SST allows fast exploration of novel hardware structures and innovative software techniques.

The SST accurately simulates each cycle of a computer system. It is built from Enkidu, a simulation package that models interactions between the different hardware pieces of a system and coordinates their internal actions. It is capable of simulating a number of components, including advanced networks (such as the Red Storm SeaStar network), modern processors, and complex memory hierarchies. By using a modular structure (Figure 1), the SST allows users to quickly reconfigure their design, adding new components and reorganizing existing ones. This flexibility has allowed the SST to explore a number of issues, such as network hardware to accelerate message processing (Figure 2), multithreaded processing, and processing-in-memory. In the case of the Red Storm's SeaStar network, the simulation identified bottlenecks, and will help design more efficient networks for future supercomputers. The SST is currently being used by a number of sites across the country to explore issues in compilers, language development, advanced packaging, and transactional memory.

Achieving new levels of computer scalability and performance is critical to support Sandia's science and engineering simulations. Several LDRD projects have used the SST to explore improved floating point architectures and processing-in-memory. With current architectures unable to provide the necessary performance, new hardware and software concepts must be explored and evaluated. The SST provides a simple, modular framework to quickly develop future architectures.

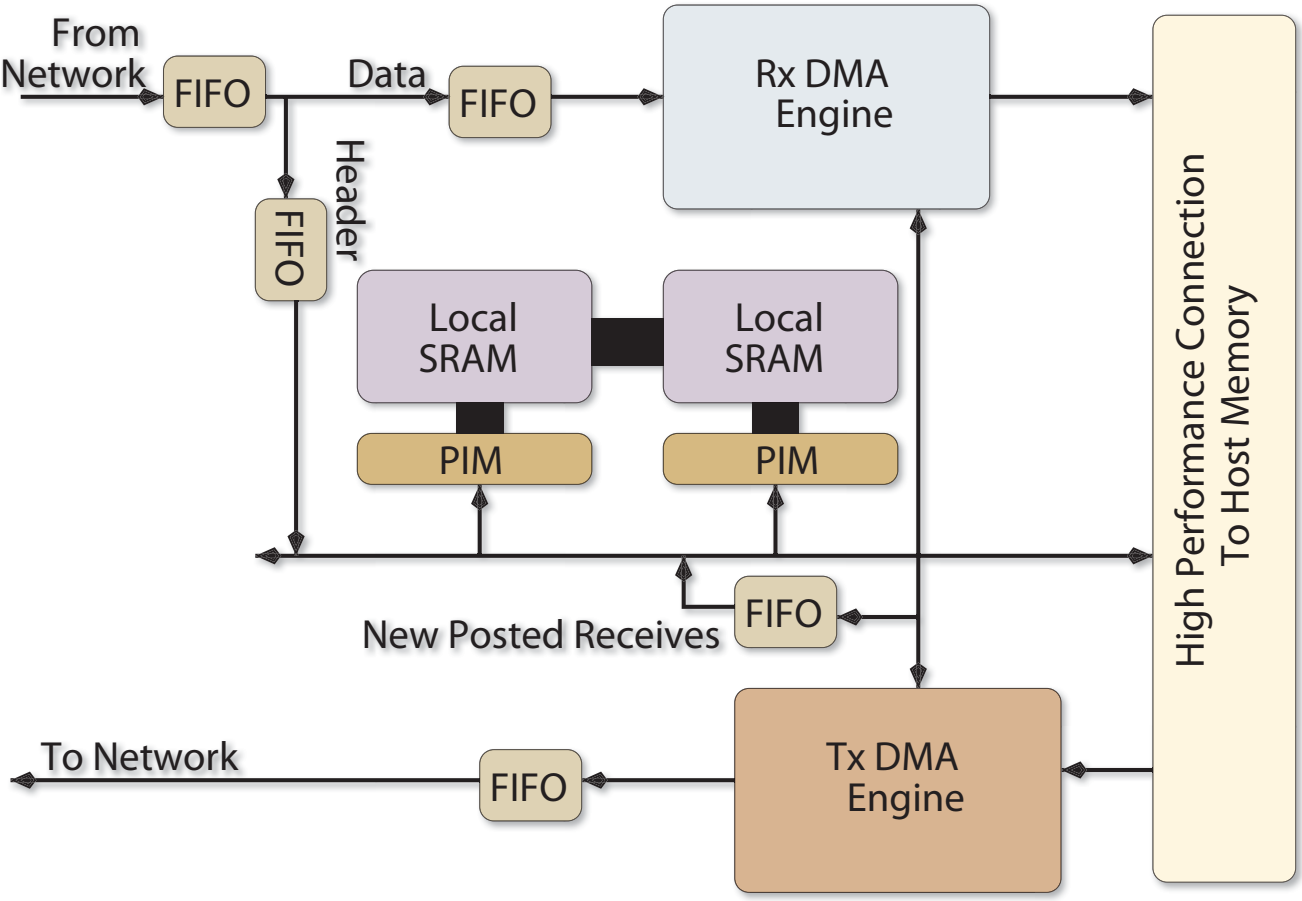

Figure 2: The simulator was used to simulate multi-threaded processors integrated into a network interface to improve message processing.

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