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Sandia National Laboratories

SST-Explorer

Enabling System-level Performance and Reliability Analysis for Designs with Real-World IPs

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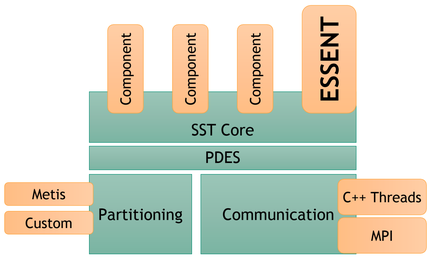
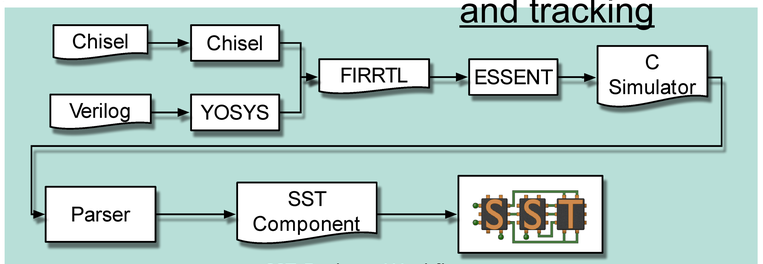
HDL Models in SST



SST provides a parallel discrete event simulation infrastructure over MPI and threads. Integrating ESSENT allows low-level (RTL) models to interact with high-level (C++) models, providing a better tradeoff between speed and model detail

Goals

- Allow mixed-mode simulations that combine RTL-level components and high-level components
- Explore Reliability with fault injection and tracking

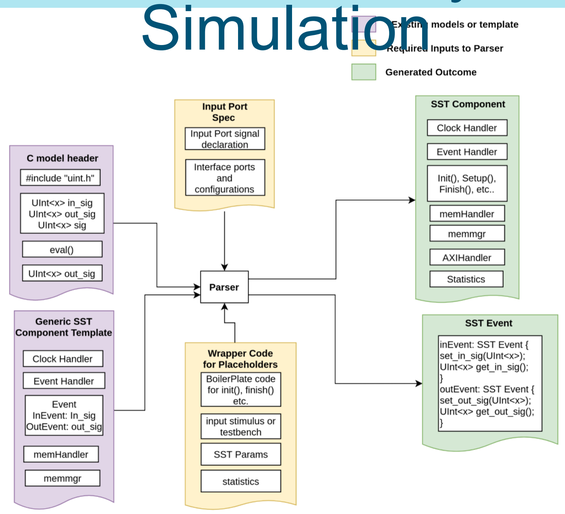


SST-Explorer Workflow

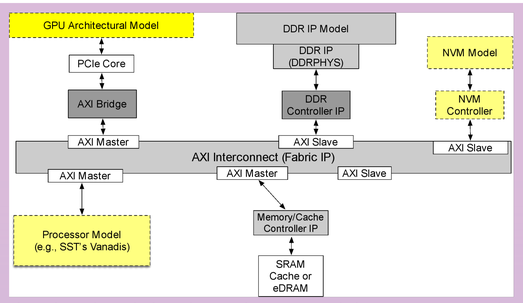
- Use of the ESSENT framework [1] allows a simple workflow which can transform Chisel or Verilog code into an SST component
- SST-Explorer parser reorganizes the C simulator created by ESSENT in to an SST component and (optionally) adds fault injection & tracking capabilities

[1] Beamer, Scott, and USDOE. *Essential Signal Simulation Enabled by Netlist Transforms (ESSENT) v1.0*. Computer software. *https://www.osti.gov//servlets/purl/1572345*. USDOE. 3 Jul. 2019. Web. doi:10.11578/dc.20191029.3.

Mixed-Fidelity Simulation



The SST-Explorer parser combines the ESSENT output with one of several templates and user supplied code and port maps to produce SST components and events. Templates include 'generic' components as well as components with UART or AXI interfaces.



Low-level and High-level Simulation Models using SST-Explorer

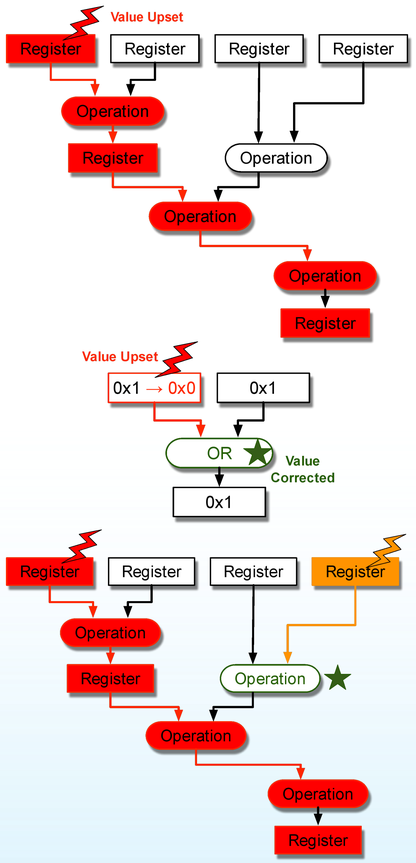
Mixed Fidelity Use Cases

- Faster high-level models can be combined with slow detailed models to improve simulation speed
- High-level "placeholder" components can be used with low-level components early in design cycle

Fault Injection & Tracking

```
template <int N>
class Uint {
    Uint_<N> origData; // correct data
    Uint_<N> data;     // faulted data
    list<upsetDesc> upsets; // record of upsets
};
```

To track faults, the ESSENT Uint<T> and Sint<T> structures are replaced with a structure that stores the original data and the data after a fault and information about the inciting upset. Operators are overloaded so the fault information is carried to the products of any operation using the operand. This allows faults to be tracked, and fault corrections to be noted.



- SST-Explorer allows not just fault injection, but fault-tracking
- When an upset occurs the register is marked and all child registers which receive 'tainted' data are noted
- If a value is corrected through an operation to its 'correct' value this is noted, allowing better understanding of fault correction mechanisms
- In the case of multiple faults, we can see which faults propagate and become actual errors

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