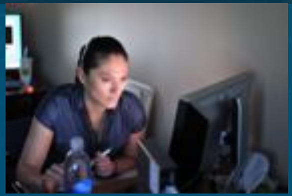
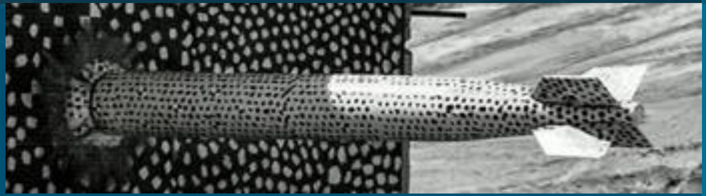
SST-Explorer

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





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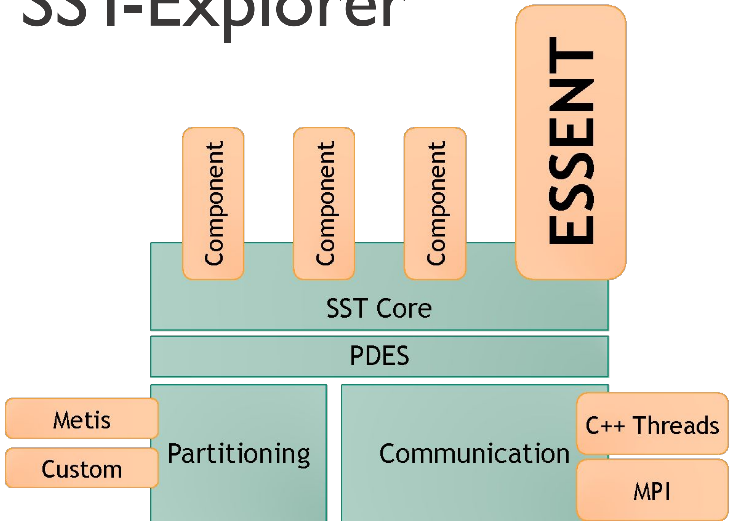
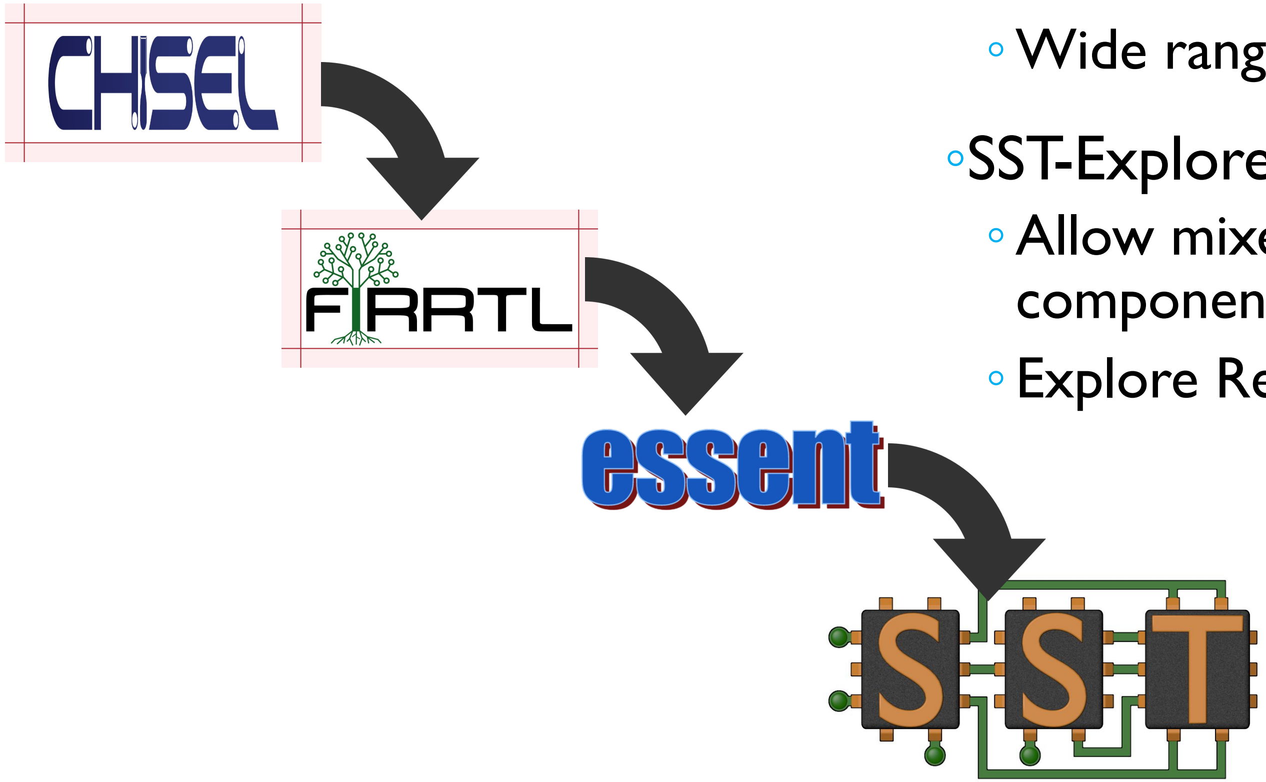
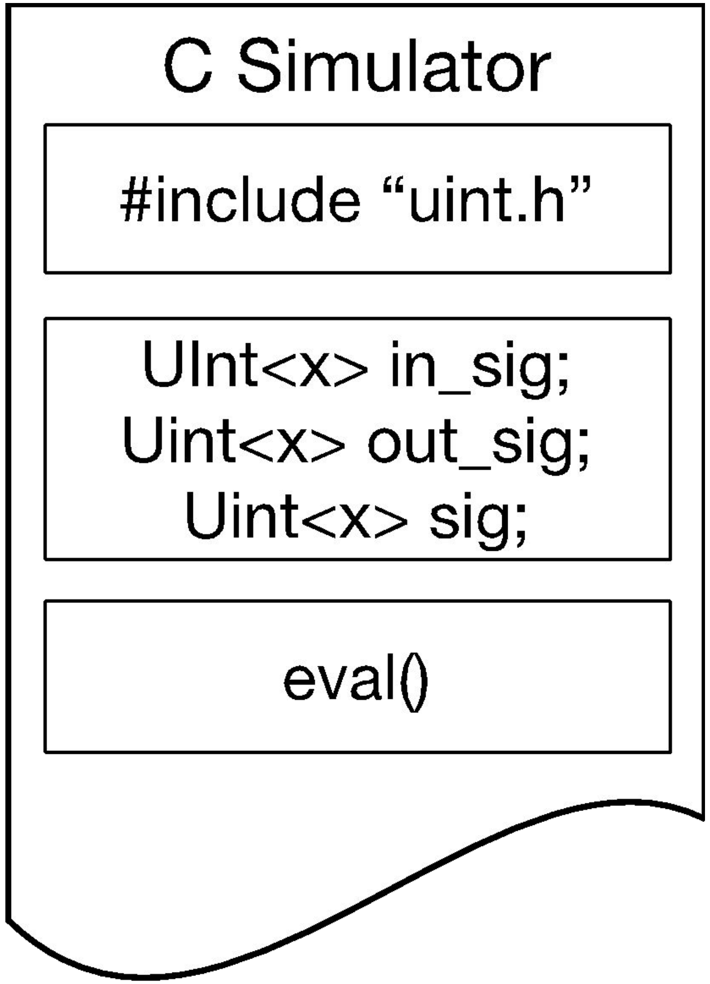
SST-Explorer





- SST: Parallel, Open, Multi-scale, Interoperable
  - SST Core framework: PDES, utilities and interfaces for simulation components
  - SST Element libraries: Libraries of components that perform the actual simulation
- C++ Models: functional to cycle-accurate
  - Wide range of models for network, processor, memory, etc…
- SST-Explorer Goals
  - Allow mixed-mode simulations that combine RTL-level components and high-level components
  - Explore Reliability with fault injection <u>and tracking</u>

ESSENT Output



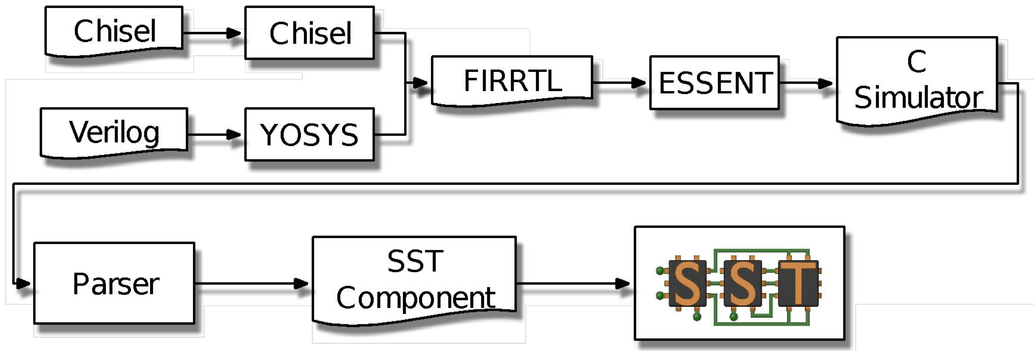
- ESSENT produces output file (.h) includes…
- Headerfile defining basic types (e.g. Uint<T>)
- List of signals (in, out, internal)
- Eval() function which does the actual simulation
- User supplies testbench wrapper code to provide input stimulus

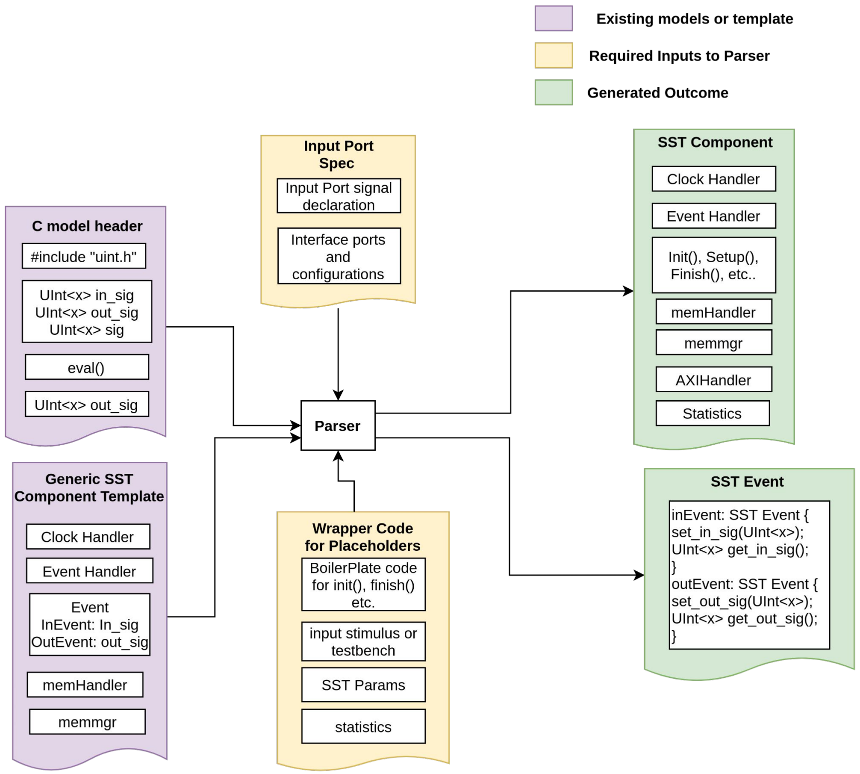
```
module Adder(
  input        clock,
  input        reset,
  input  [7:0] io_in0,
  input  [7:0] io_in1,
  output [7:0] io_out
);
  assign io_out = io_in0 +
io_in1;
endmodule
```

```
#include <uint.h>

typedef struct Adder {
  UInt<8> io_in0;
  UInt<8> io_in1;
  UInt<8> io_out;

  void eval() {
    UInt<9> _T = io_in0 + io_in1;
    io_out = _T.tail<1>();
  }
} Adder;
```

SST/ESSENT: Workflow

- SST-Explorer framework 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
  - (optionally) adds fault injection & tracking capabilities
- ESSENT output + Template + user supplied code and port maps → SST Components and Events.
  - Templates: 'generic' components, UART-based, or AXI interfaces.
- Use cases
  - Fast high-level models + slow detailed models = improve simulation speed
  - High-level "placeholder" components + low-level components early in design cycle





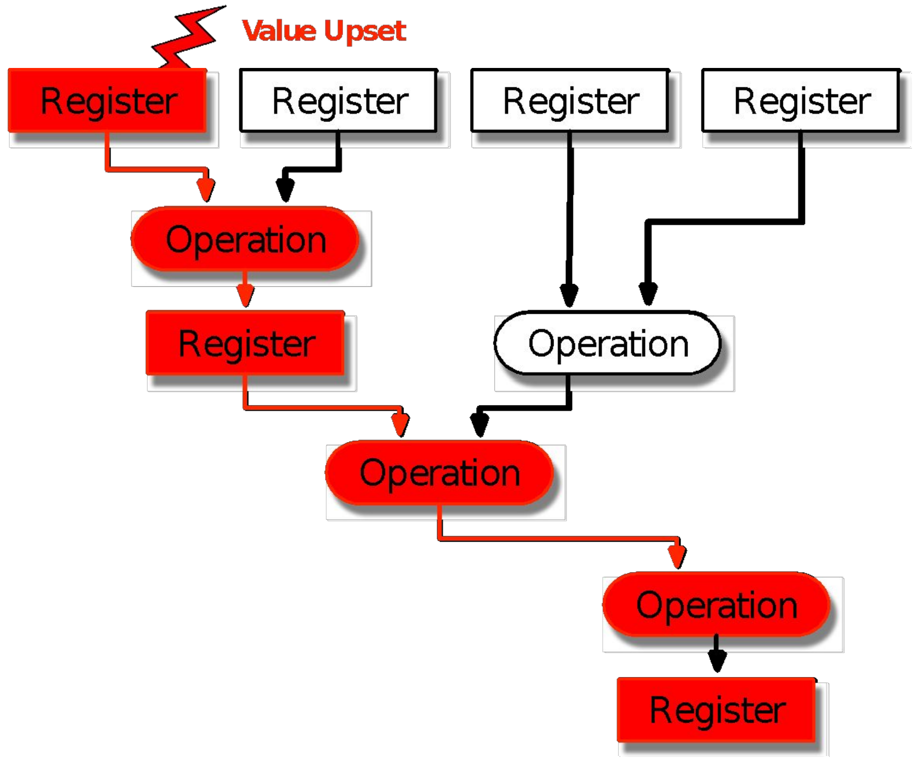
Fault Tracking

◦ SST-Explorer allows fault injection **and tracking**

◦ ESSENT Uint<T> and Sint<T> structures replaced
  - New structure stores original data, "faulty" data, and info on inciting upset
  - Operators overloaded so fault information is propagated
  - Faults are tracked and fault corrections are noted

◦ For each fault
  - Where it started
  - What it affected

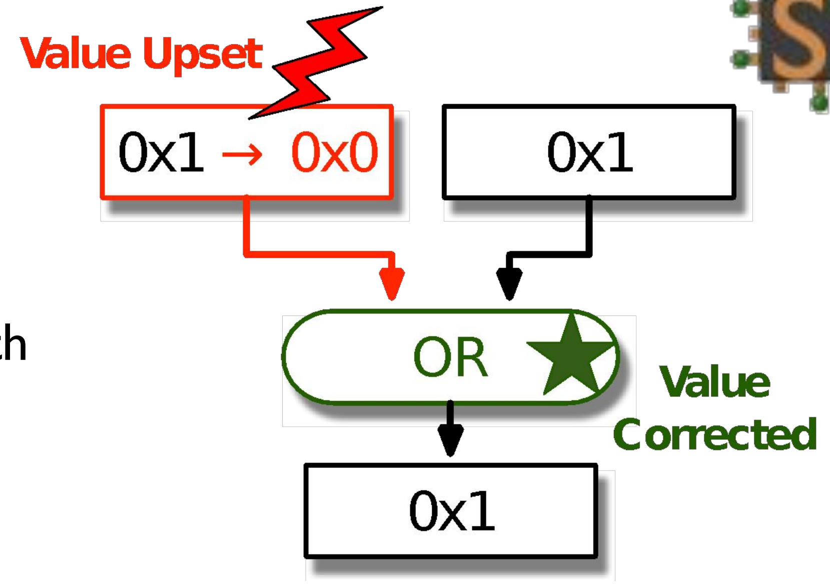
```
template <int N>
class Uint {
  Uint_<N> origData; // correct data
  Uint_<N> data;     // faulted data

  list<upsetDesc> upsets; // fault track
};
```



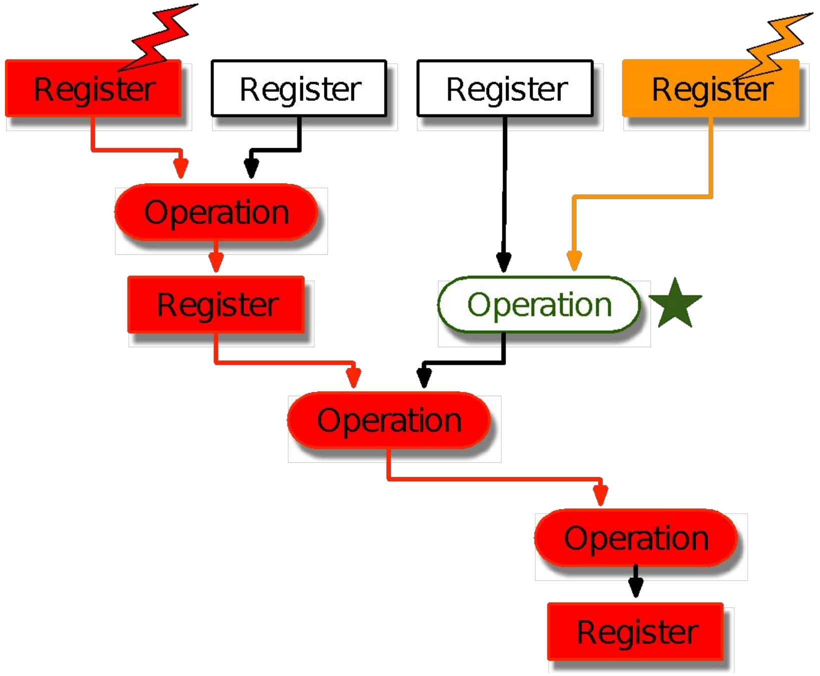
Fault Corrections & Diagnosis

- Other Use Cases
  - Detect fault corrections
    - Data struct carries 'correct' value, can determine if math operations restore faulted to correct
    - Useful for determining where faults squashed
  - Multi-fault diagnosis
    - Origin of each fault is tracked
    - Can determine which upset (of many) caused fault or error

- Summary: SST-Explorer
  - RTL models to be integrated with SST
  - Fault injection <u>& tracking</u>



Fault Correction



Multi-Fault Diagnosis