High-Level System Design Using Foresight

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IT / CE

Outline

- Development Process
- HW/SW Co-Design
- Foresight: a Modelling and Simulation tool
- ALICE DAQ System

Development Process (1)

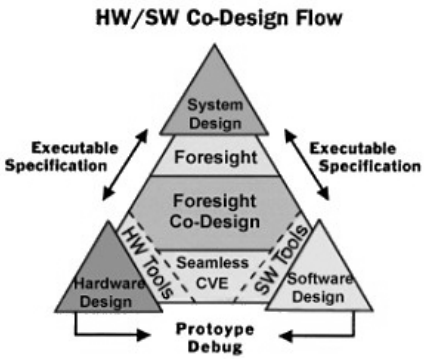
- Separate Functionality from Architecture
  - Design system functionality before thinking at hardware/software implementation details
- Formal Specification and Verification
  - Mathematical definition of system (unambiguous)
  - Semantics of specification provides a model
  - Behaviour of model = behaviour of system
  - Verification: model behaves correctly (simulation, model checking)

Development Process (2)

- First Phase: Functional Requirements
  - **Abstract specification**: interfaces, functionality
  - **Verification**: incomplete/inconsistent functional requirements, performance problems, design errors
  - **Analysis**: critical parameters, maximum (minimum) performances, particular conditions
- Second Phase: Architectural Concerns
  - **Detailed specifications**: algorithms, hardware choices, alternative architectures
  - **Verification, analysis**: check requirements and performances

HW/SW Co-design

- Foresight Systems, Inc.
- System Design
  - Foresight tool
  - Specification Execution
- System Co-design
  - Foresight co-design tool
  - Foresight specification with hw/sw components
  - Specification Execution
- HW/SW Components
  - HDL simulation environment
  - Seamless CVE



Foresight (1)

- Foresight Tool
  - System Level Modeling and Simulation Tool
- Specification
  - Hierarchical Specifications
  - Data Flow Diagrams (event-driven processes, events, control)
  - State Transitions
  - Mini-specs
  - Real-time parameters

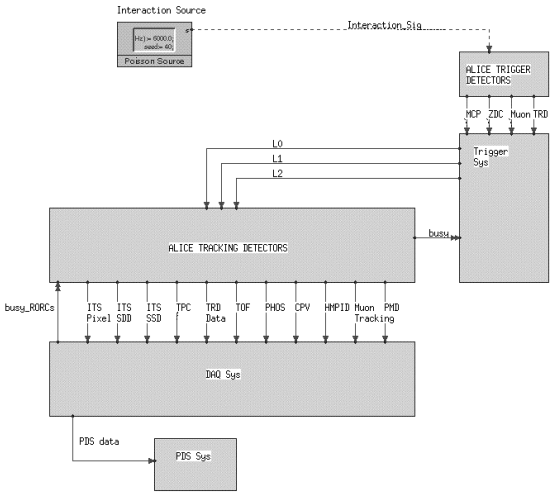
Foresight (2)

- Analysis
  - Type checking, input/output checking, syntax errors
- Execution of Specification (Simulation)
  - Real-time execution of specification
  - Stand-alone executable specification
  - Animation of Diagrams
  - Real-time constraint validation
  - Debugging functions (breakpoints, monitors windows)
  - Simulation is NOT formal verification !
  - Works on Sun workstation

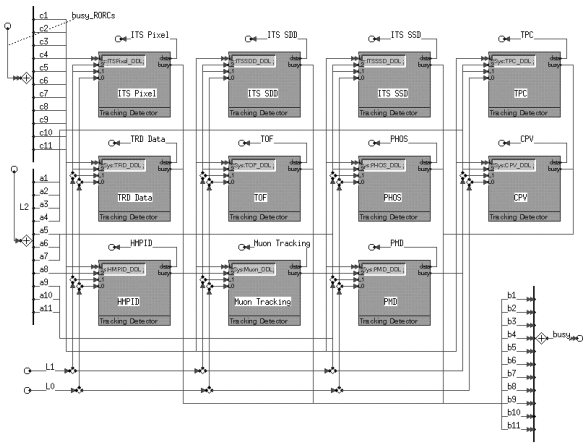
ALICE DAQ

- Model of whole ALICE DAQ System
  - Trigger System (L0, L1, L2)
  - Trigger and Tracking Detectors
  - DAQ (with sub-event building, event building, storage)
  - Parameters (buffer sizes, etc.)
- Evaluation of Performances
  - Whole system: maximal bandwidth / real bandwidth
  - For each detector: buffer occupancy, bandwidth usage
- Alternative Algorithms
  - Event building computing
  - L2 trigger decision

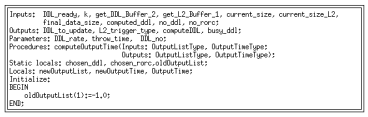
ALICE: Overall System

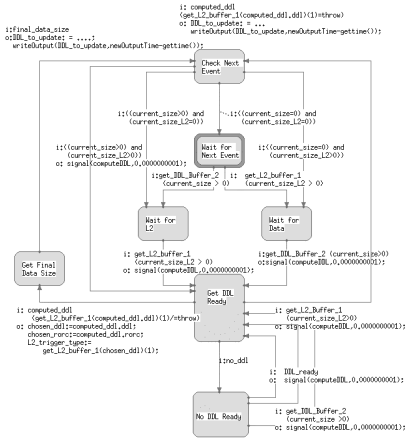


ALICE: Tracking Detectors



ALICE: FSM, Mini-Spec






```
Inputs:   data;
Outputs:  bandwidth_rate;
Static locals: total_data_size;

Initialize:
BEGIN
    total_data_size:=0.0;
END;

Procedure:
BEGIN
    total_data_size:=total_data_size + data.data_type.size;
    bandwidth_rate:=total_data_size/gettime();
END;
```


Results

Maximal Bandwidth

	L0	L1	L2
Central	137	133	92
Dimuon	462	457	585
Dielectron	159	152	197
Minbias	747	714	409
Misc	203	197	
Interaction	1997		

After 1 sec (6038 ev)
Expected at L2:

	Buffer Full	Bandwidth	Maximum
TPC	23	14200 MB/	18000Mb/
TRD	43	1627MB/	1800MB/

	C	MB	DM	DIEL	Total
L2	20 H	20 H	650 Hz	200 Hz	890 Hz

Conclusion

- Separate Functionality from Architecture
- Foresight Systems provides integrated tools
  - Formal Specification and Execution
  - Seamless replacement of formal components by hardware/software components
  - `http://www.nuthena.com/`
- Advantage
  - Correct errors before implementation
  - Think about the functional level (correct interfaces)