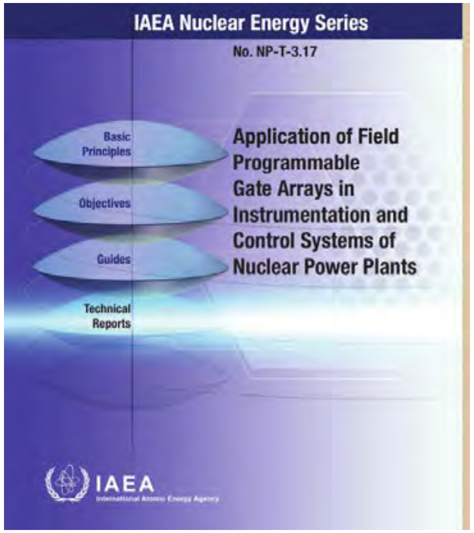
Intelligent RTL Simulation Platform for Nuclear Safety System Application based on FPGA

融创之道

Catalog

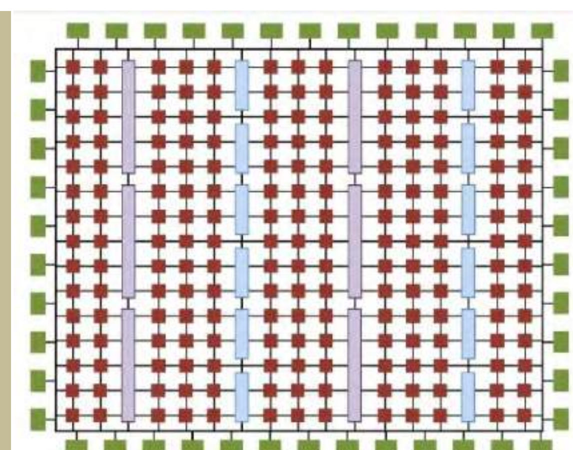
1. Background
2. Intelligent RTL Simulation Platform Architecture
3. Implementation steps
4. Results and Analysis
5. Conclusion

1. Background



According to this report, the FPGA has the advantages such as *"As opposed to microprocessor based systems, which are mostly general purpose machines, FPGA based systems can be designed to include only the required functionality, and thus there are no hidden functions that might remain either untested or express themselves in unpredicted ways under certain machine states. "* This means we can **detect and observe the behavior of each basic unit** of the FPGA.

With powerful EDA tools, intelligent and flexible simulation platforms are built to reproduce the actual application configuration, and basic circuit behaviors are observed, which can greatly promote the development, application and maintenance of FPGA-based safety-level platforms.



2. Intelligent RTL Simulation Platform Architecture

NicSys® 8000N based on FPGA is a general safety-level I&C system platform which can be used in a variety of type of NPPs(such as AP1000, ACP1000 etc., including the RPS, PAMS, ESFAS, etc., designed by China Nuclear Control Systems Engineering Co., Ltd (CNCS).

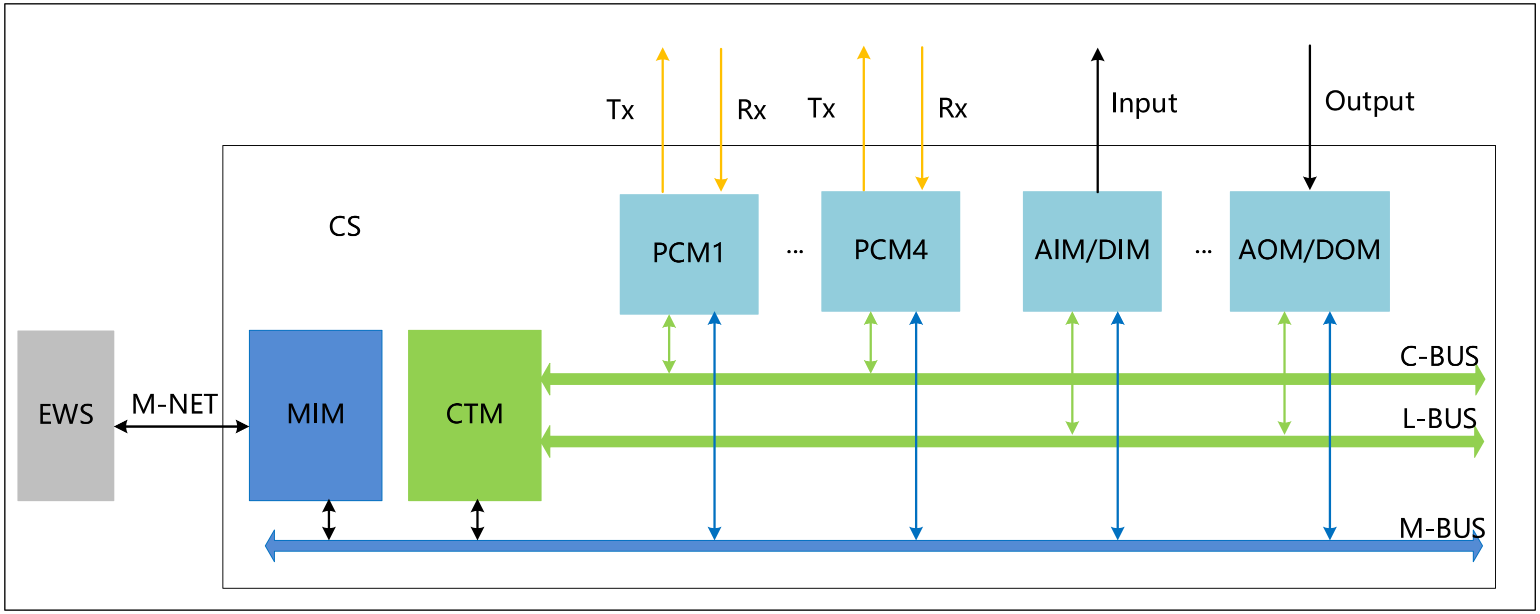
Front

Rear

Name	Function
MIM	Maintenance Interface Module is used to achieve platform configuration and maintenance interface.
CTM	Controller module is the key process module of the platform, which receives data from I/O modules or communication modules, perform logic process and then output the results. The module supports hot standby redundancy configuration operating as master or slave.
PCM	Point-to-point communication module is used to achieve the intra-divisional or inter-divisional communication
AIM	Analog Input module, supporting voltage or current signals
AOM	Analog output module, supporting voltage or current signals
DIM	Discrete input module (24V/48V), supporting 24V/48V signal or contact signal
DOM	Discrete output module

2. Intelligent RTL Simulation Platform Architecture

➢ NicSys8000N platform connection



fulfill：

√ The actual module configuration and connection is simulated

√ The actual communication and connection is simulated

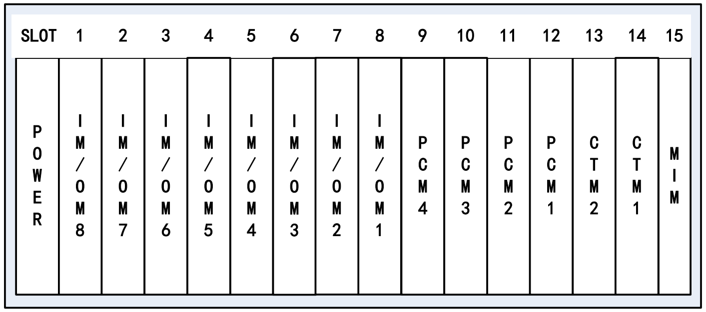
√ The actual working conditions of the product (normal, instantaneous, fault) are simulated

2. Intelligent RTL Simulation Platform Architecture

□Pre-define the module type for each module

MIM	CTM	PCM	DIM	DOM	NULL
01	02	03	04	05	FF

□ ID assignment to the slot according to the configuration

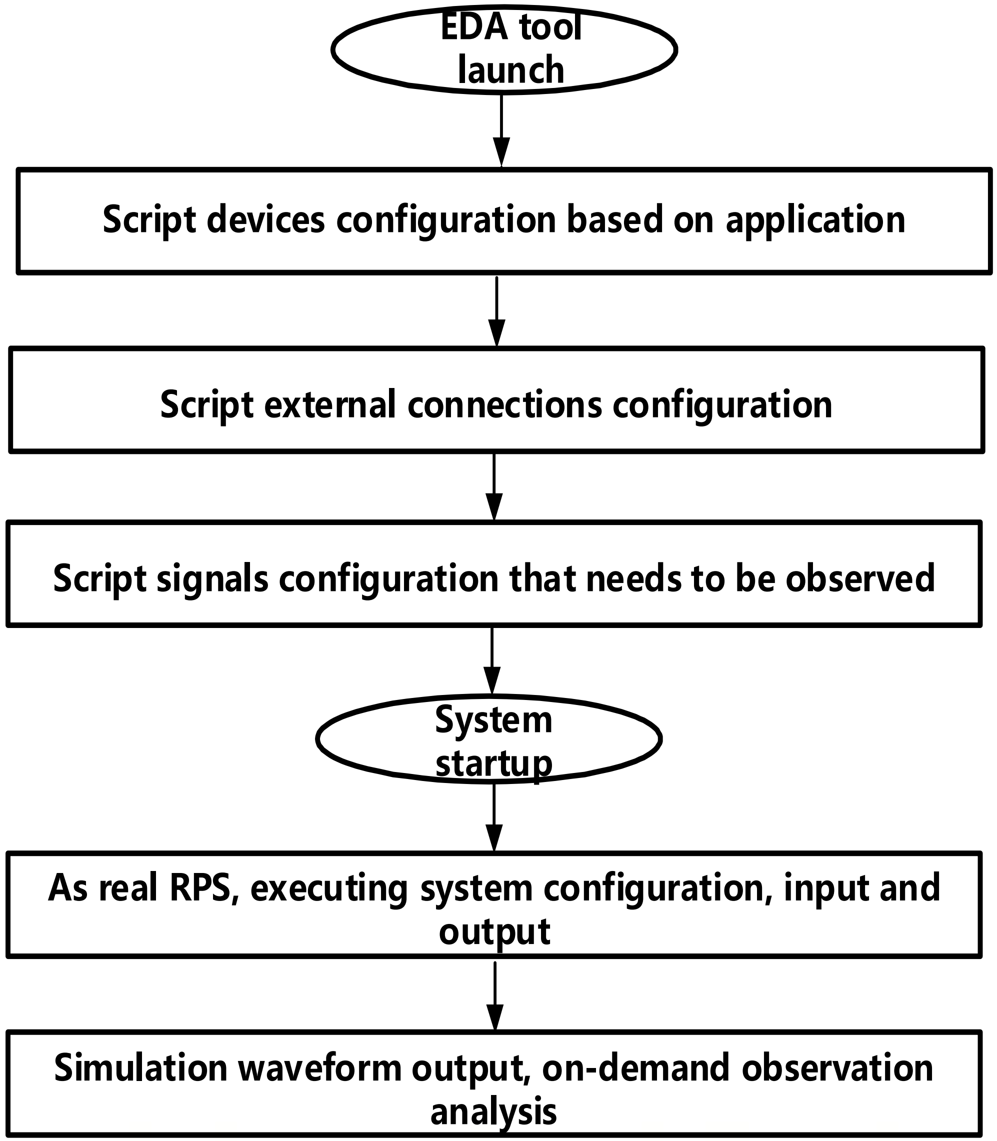


□ Scripted configuration

```
parameter   board15 = {rack0, slot15, MN811};
parameter   board14 = {rack0, slot14, NP811};
parameter   board12 = {rack0, slot12, CM811};
parameter   board11 = {rack0, slot11, CM811};
parameter   board6  = {rack0, slot6, DI812};
parameter   board5  = {rack0, slot5, DO811};
parameter   board3  = {rack0, slot3, DO811};
parameter   board1  = {rack0, slot1, DI812};
```

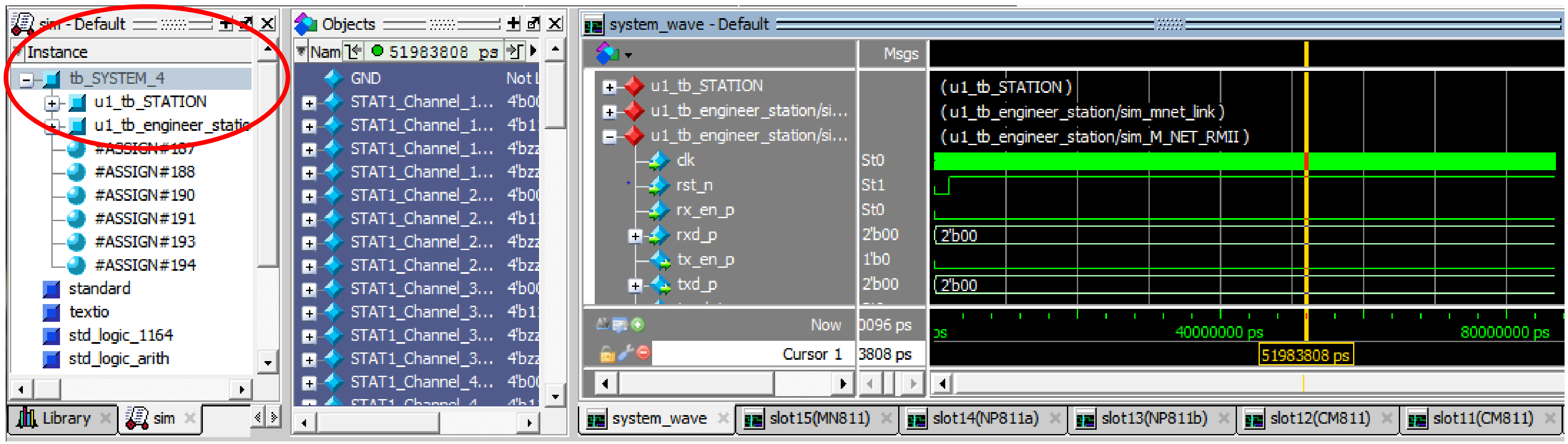
```
parameter   board15 = {rack0, slot15, MN811};
parameter   board13 = {rack0, slot13, NP811};
parameter   board11 = {rack0, slot11, CM811};
parameter   board9  = {rack0, slot9, CM811};
parameter   board5  = {rack0, slot5, DI812};
parameter   board3  = {rack0, slot3, DO811};
parameter   board2  = {rack0, slot2, DI812};
parameter   board1  = {rack0, slot1, DO811};
```

3. Implementation steps



4. Results and Analysis

- **Results can be observed and analyzed at any level**
- ***tb_SYSTEM***
- ***tb_engineer_station***
- ***tb_STATION***

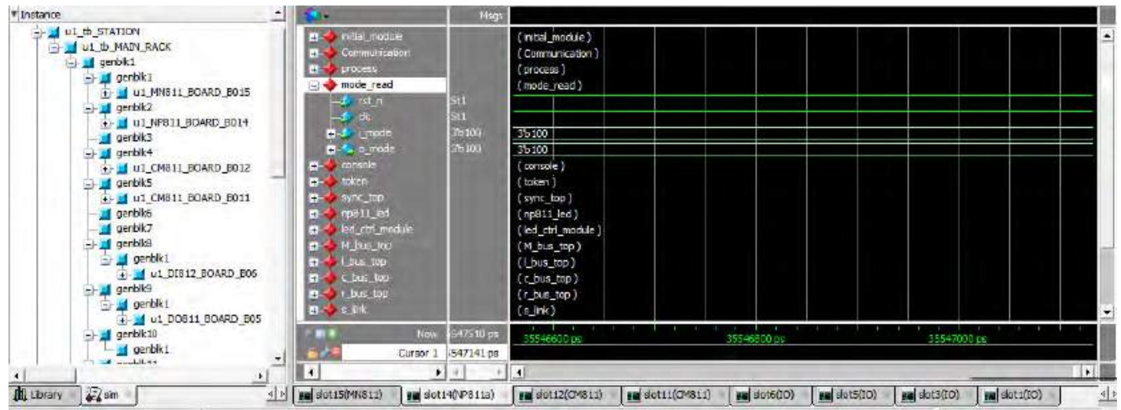


4. Results and Analysis

□ The figures below show the simulated waveforms in two different operating conditions and configurations.

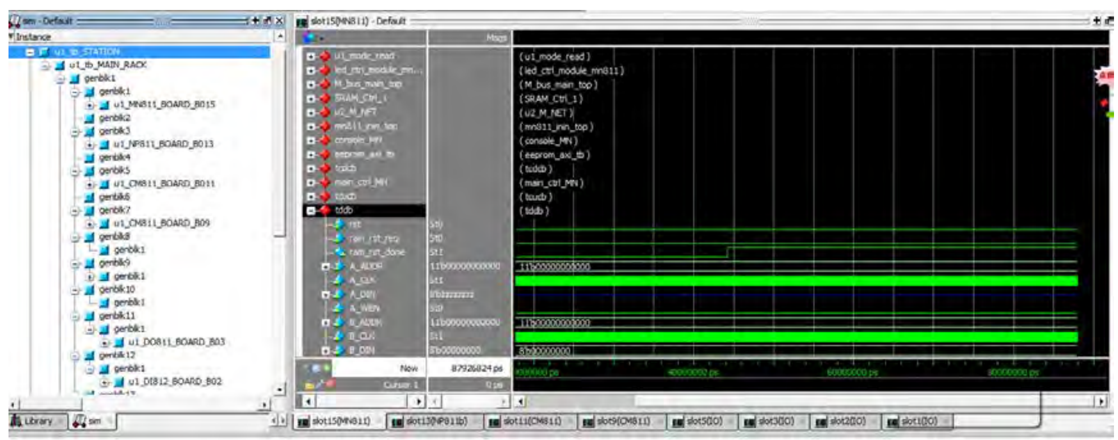
➢ ONE

```
parameter  board15 = {rack0, slot15, MN811};
parameter  board14 = {rack0, slot14, NP811};
parameter  board12 = {rack0, slot12, CM811};
parameter  board11 = {rack0, slot11, CM811};
parameter  board6  = {rack0, slot6, DI812};
parameter  board5  = {rack0, slot5, DO811};
parameter  board3  = {rack0, slot3, DO811};
parameter  board1  = {rack0, slot1, DI812};
```



➢ TWO

```
parameter  board15 = {rack0, slot15, MN811};
parameter  board13 = {rack0, slot13, NP811};
parameter  board11 = {rack0, slot11, CM811};
parameter  board9  = {rack0, slot9, CM811};
parameter  board5  = {rack0, slot5, DI812};
parameter  board3  = {rack0, slot3, DO811};
parameter  board2  = {rack0, slot2, DI812};
parameter  board1  = {rack0, slot1, DO811};
```



5. Conclusion

Simulated reality

Simulating I&C different working in actual nuclear power plants

Module independently

Plug and play of any module model

No missing signal capture

Any activity in every basic unit can be simulated

Configuration intelligently

According to the application configuration of NPPs, intelligently configurating the installation location and board type