Application of FPGA technology in NicSys8000N platform

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Presentation Overview

◆ Introduction

◆ Structure of NicSys8000N platform

◆ FPGA technology strengthen the NicSys8000N

platform comprehensively

◆ Application of FPGA technology in
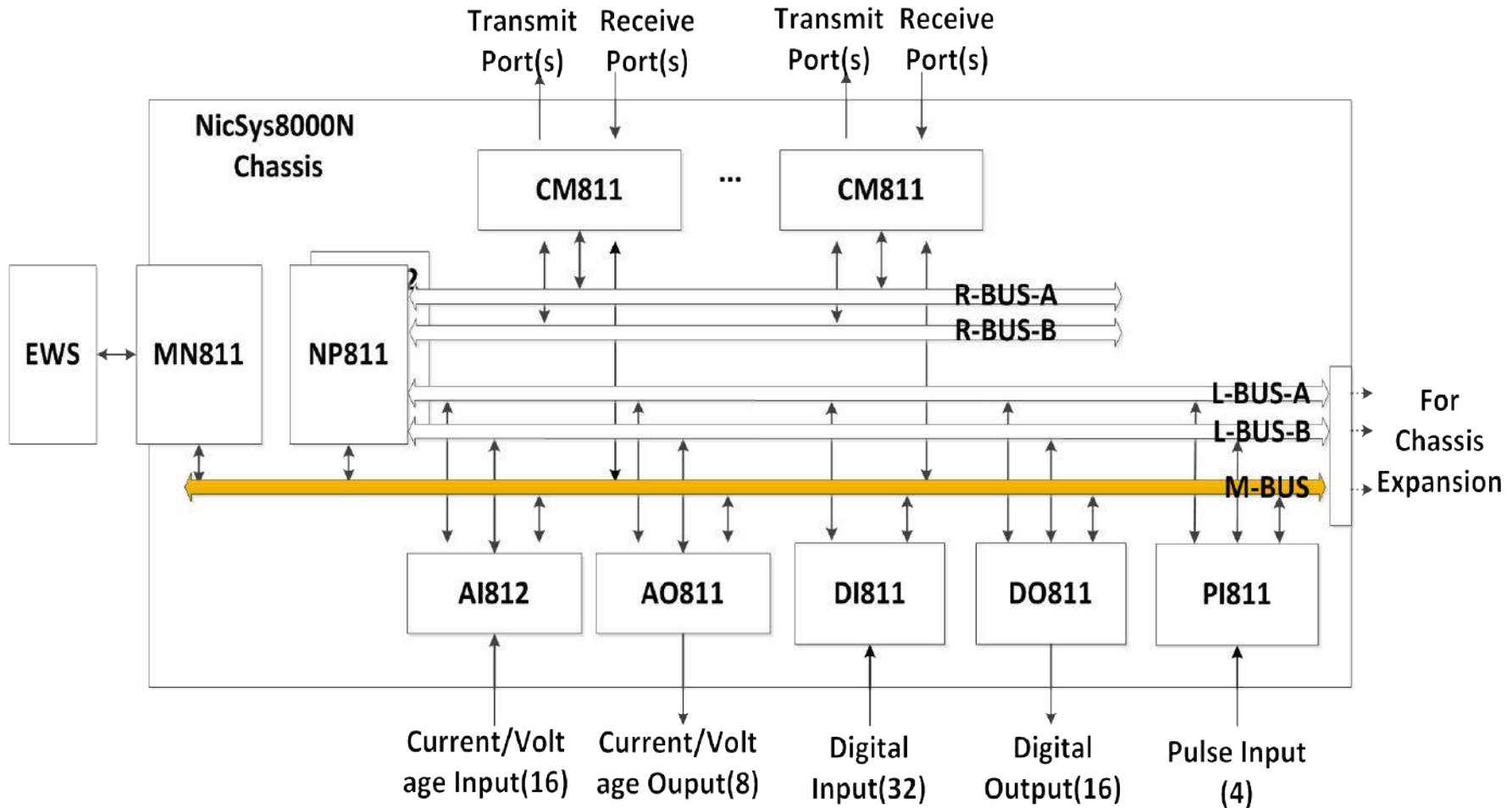
NicSys8000N platform

◆ Conclusion

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◆Introduction

- The NicSys8000N platform is a hardware-based architecture that uses a minimal set of hardware to implement a system with high reliability and integrity. The system incorporates self-test capability for detection and mitigation of the effects of failures within or external to the system.

- The key component in the NicSys8000N platform design is a field-programmable gate array (FPGA). The FPGA programmable logic components can be programmed to duplicate the functionality of basic logic gates (such as AND, OR, XOR and NOT). These logic components can be combined into more complex combinational functions such as decoders or math functions.

- The NicSys8000N uses much technology to strengthen the NicSys8000N platform comprehensively.

◆Structure of NicSys8000N platform

◆Structure of Controller
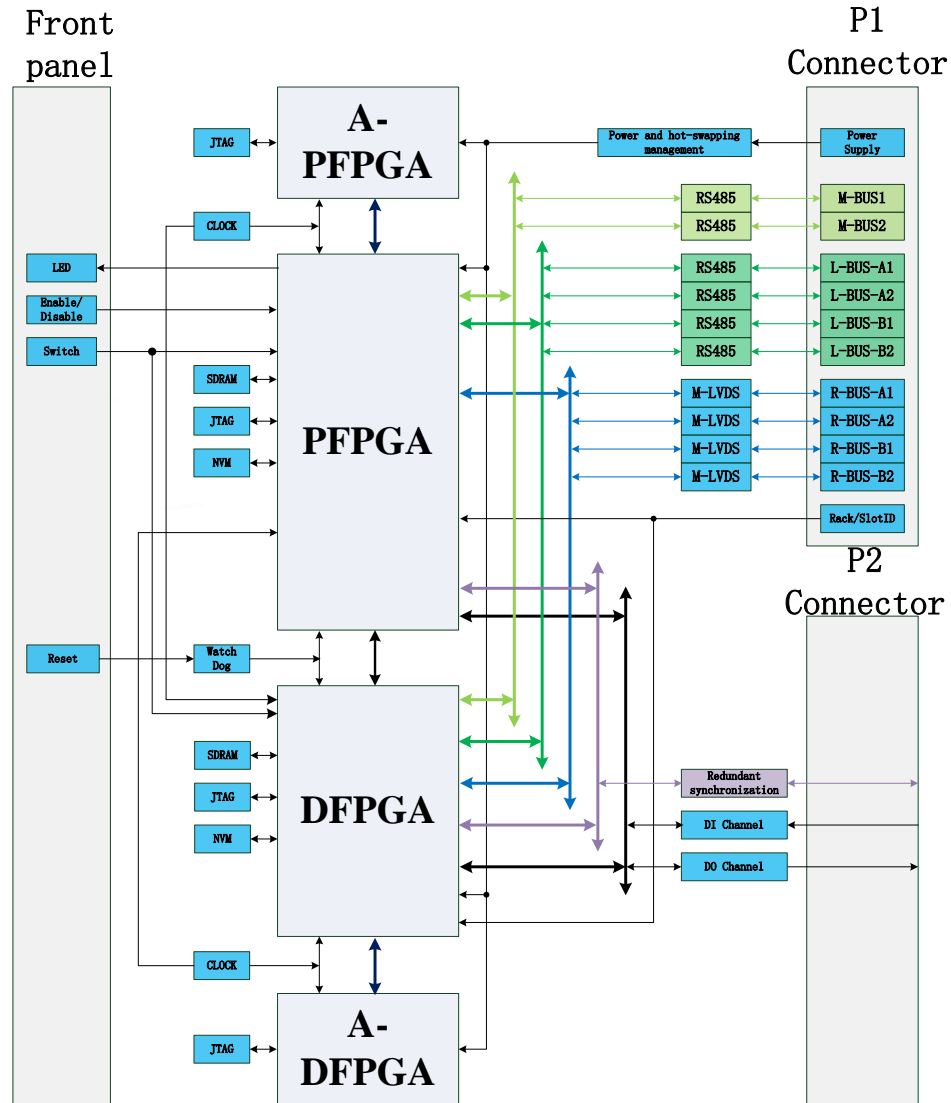
◆FPGA technology strengthen the NicSys8000N platform comprehensively

- ➢ More safety

- ➢ More quickness

- ➢ More simplicity

- ➢ More security

More safety –using seu-immune device

✓ Microsemi flash-based FPGA

• Single event upset (SEU) immune

- Zero FIT FPGA configuration

• Single error correct double error detect(SECDED) protection on some units

• NVM integrity check at power-up and on-demand

• No external configuration memory required

- Instant-on, retains configuration when powered off

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More safety –using redundancy technology

✓ System can work in several redundant ways

1) Parallel redundancy

2) Hot-backup redundancy

✓ Safe communications are redundant. So if each wire is broken, the work is continually normal, excepting alarm generation .
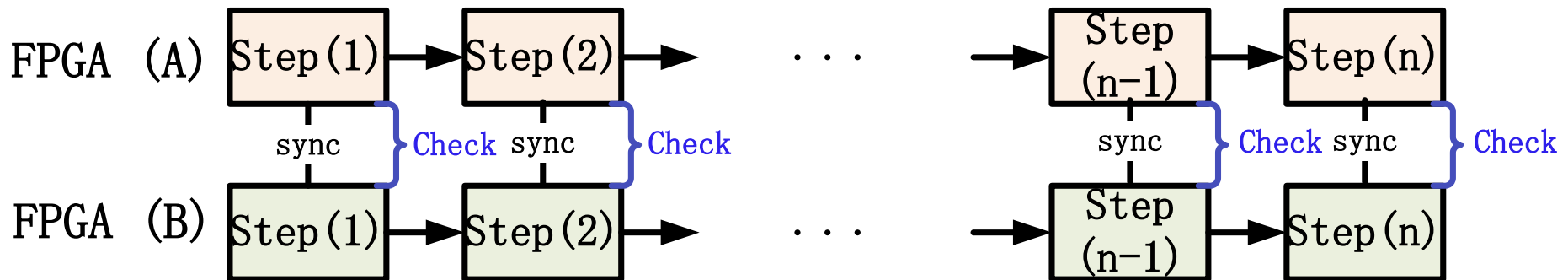
◆ Application of FPGA technology in NicSys8000N platform

More safety –using lockstep technology

All of the cards include two FPGAs that operate in lockstep with one another. They must remain synchronized with one another in order for any process to be completed without failure.

◆ **Application of FPGA technology in NicSys8000N platform**

More safety —using diversity technology

Item	FPGA（A）	FPGA（B）
FSM Structure	2-stages	3-stages
FSM Encoding	One-Hot	Gray Code
Computation	Normal logic	Opposite logic
Physical placement	Pin-assigned A	Pin-assigned B

✓ Independent designers

✓ FPGA from different vendors

More safety —using diagnostic technology

✓ composite fault diagnostic

Each safety-related function is performed by at least two items. We use two FPGAs to execute most logic process and compare their results.

✓ reactive fault diagnostic

A safety-related function to be performed by a single item, provided its safe operation is assured by rapid detection and negation of any hazardous fault. The channel circuits are performed diagnosis in this way.

More safety−using fail-safe technology

✓ inherence fail-safe: cut off power supply

Power Supply

Relay
Fail-safe
signal

FPGA

Control signal

Relay
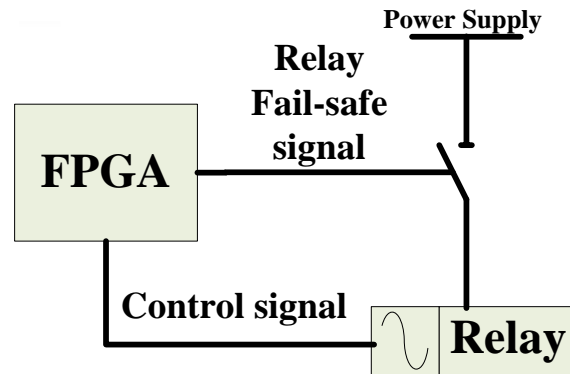
✓Inherence fail-safe: loss of dynamic signals

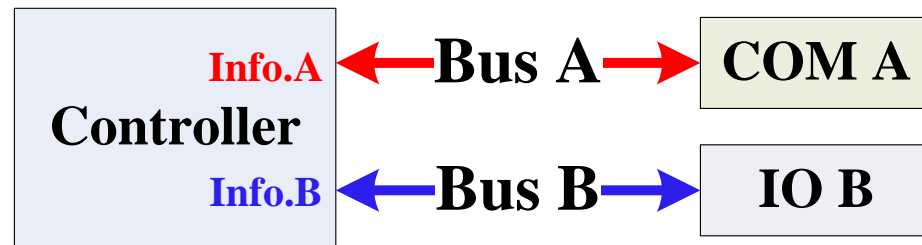Fail-safe signal

FPGA

. . .

Fail
Performance

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◆ **Application of FPGA technology in NicSys8000N platform**

More quickness –using cooperation technology

✓ Several cards deal with different tasks meanwhile
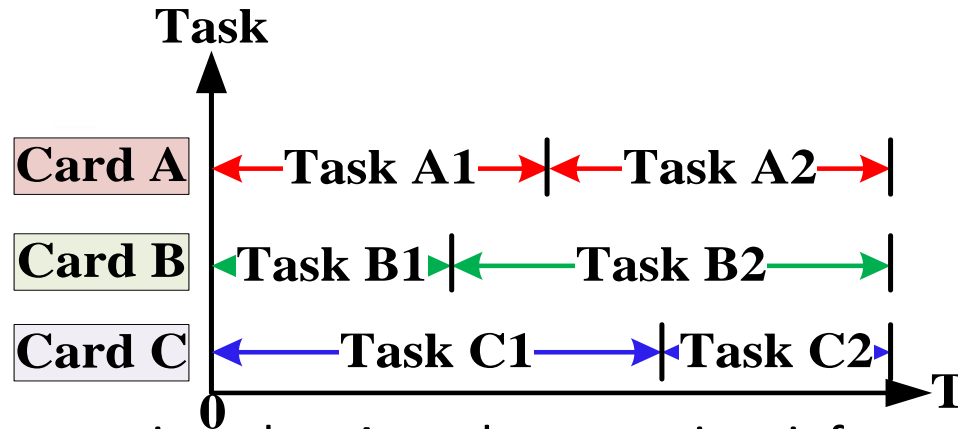
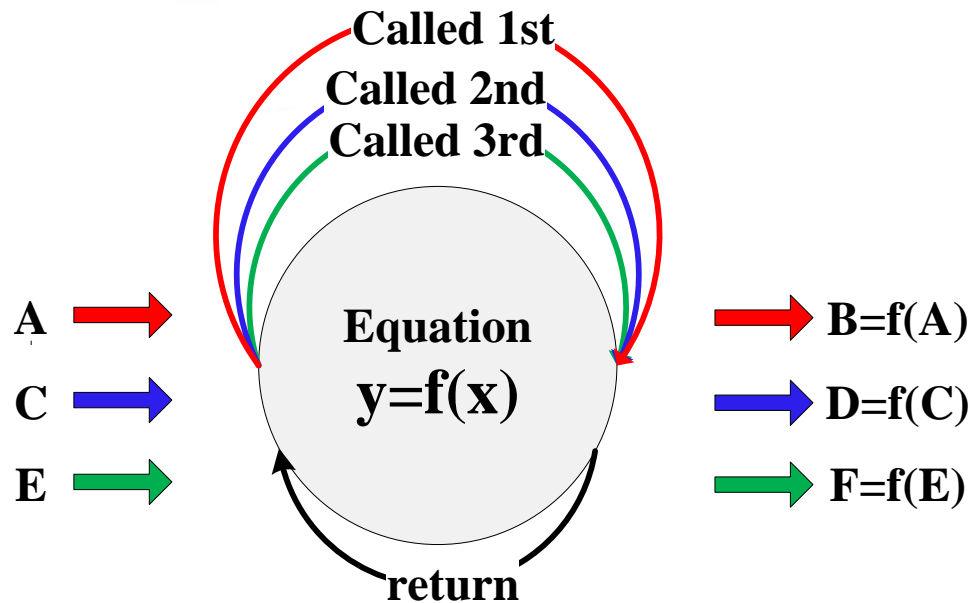✓Information A is transmit on bus A, at the same time information B is transmit

on bus B

✓ May use FPGA arrays to satisfy amount of complicated algorithm

More quickness −using parallel computation technology

Traditional software execution is serial, and one algorithm will be called over

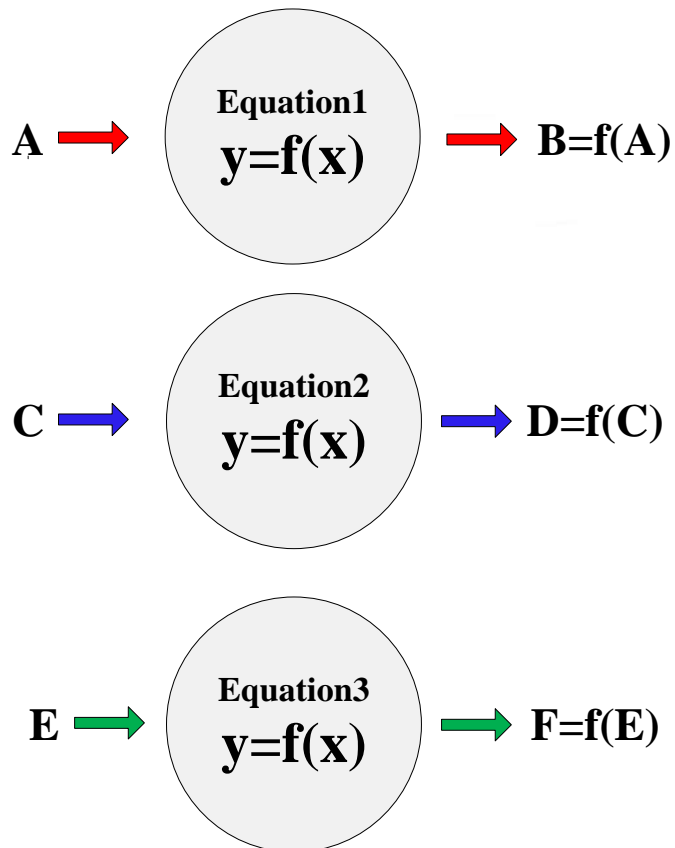once. In FPGA it can be as the same, as follow:

What's the advantage and disadvantage in this way?

More quickness −using parallel computation technology

Each equation is called separately, as follow:

A $\longrightarrow$ **Equation1** $y=f(x)$ $\longrightarrow$ **B=f(A)**

C $\longrightarrow$ **Equation2** $y=f(x)$ $\longrightarrow$ **D=f(C)**

E $\longrightarrow$ **Equation3** $y=f(x)$ $\longrightarrow$ **F=f(E)**

Advantage：

• Application translated more clearly

• Avoid CCF

• More quickly

Disadvantage：

• Cost more glue-logic resource

More quickness –using pipeline technology

The most characteristic of the pipeline operation is that the data stream is processed like flowing water.
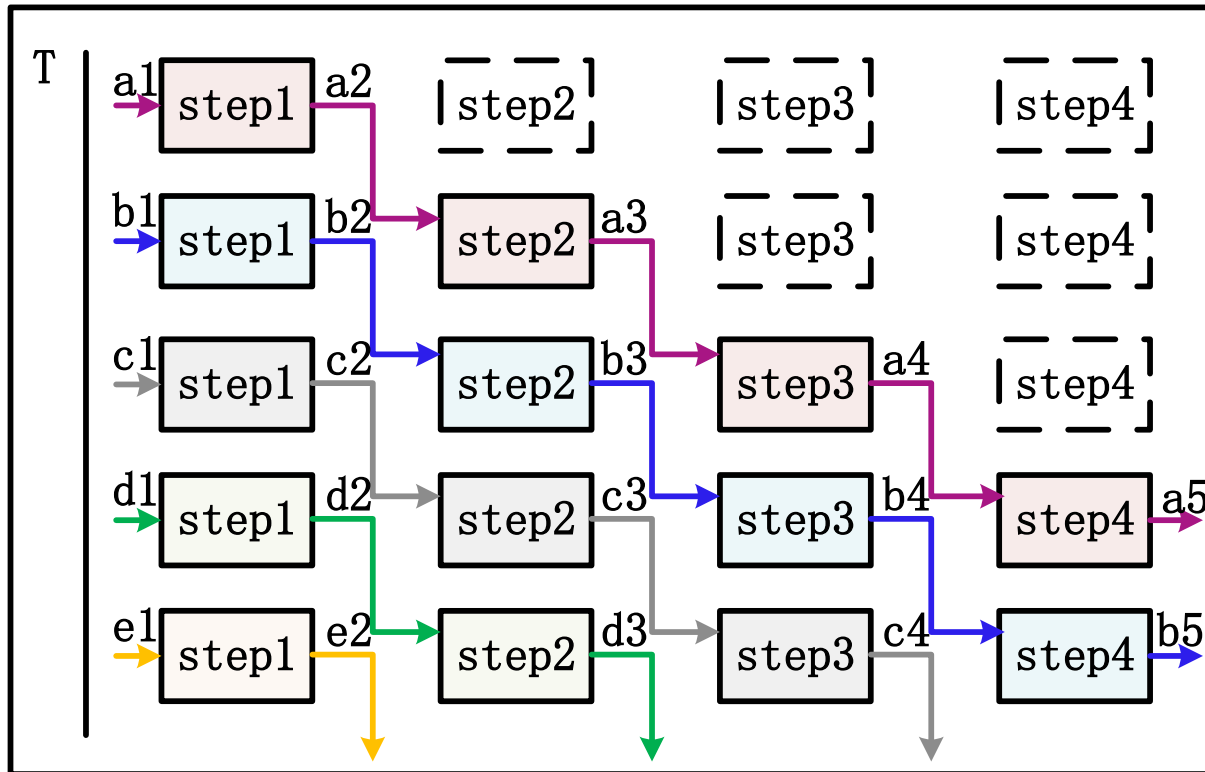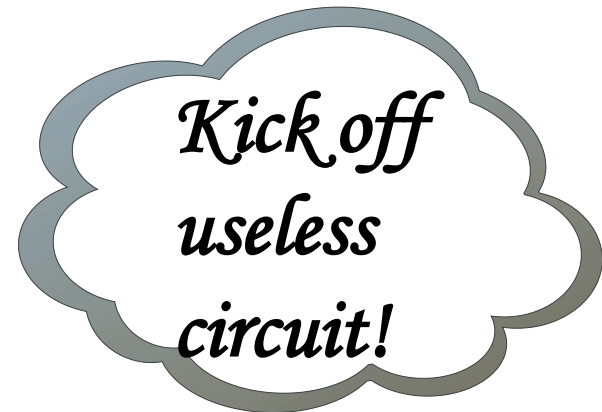
More simplicity −using no-use-no-exist technology

✓ no superfluous function

✓ no superfluous module

✓ no superfluous state

✓ no superfluous port or variable

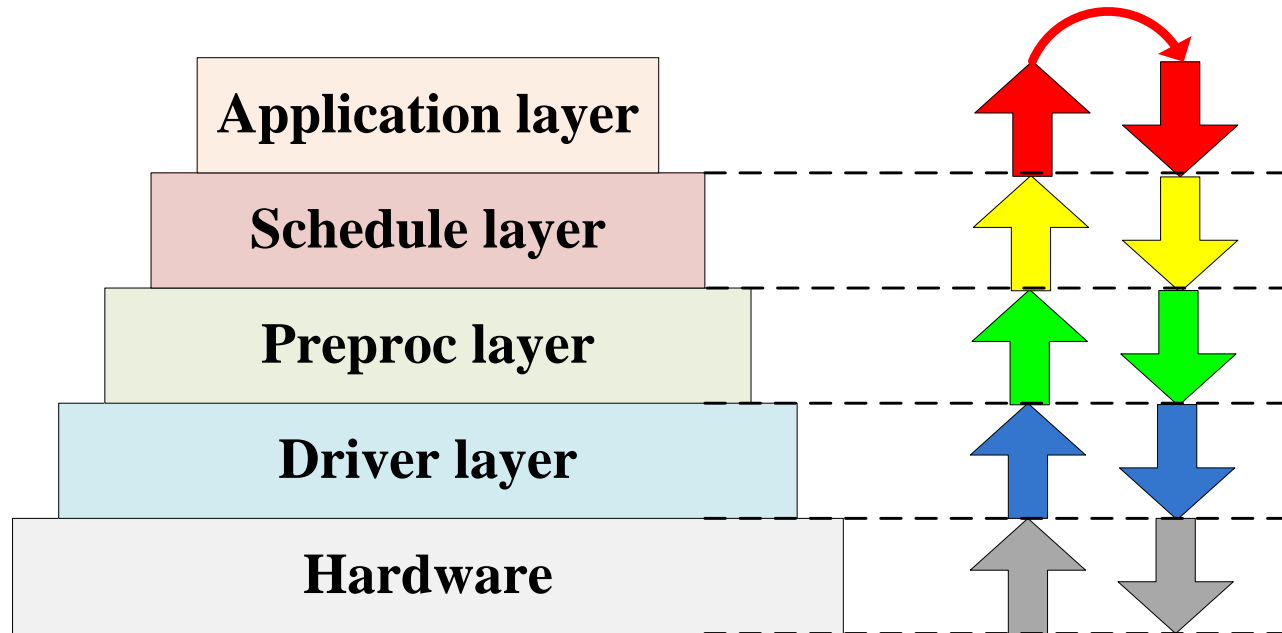*Kick off useless circuit!*

Any glue-logic is definitized, so V&V should have much work to check these.

More simplicity –using software hierarchical structure

technology

| Application layer |
| Schedule layer |
| Preproc layer |
| Driver layer |
| Hardware |

✓ more clear datapath

✓ more clear interface

◆ **Application of FPGA technology in NicSys8000N platform**

More security −using microsemi encryption device

✓ Intellectual Property (IP) protection via unique security features and use models new to the PLD industry

✓ Encrypted user key and bitstream loading, enabling programming in less-trusted locations

✓ Supply-chain assurance device certificate

✓ Enhanced anti-tamper features

✓ Zeroization

More security—using authentication technology

All communication protocols and methods are implemented in closed and proprietary architecture.
✓ Inspection of received data structure
✓ Inspection of received data type
✓ Inspection of received data range
✓ Inspection of received data order
✓ Inspection of received data shift rate
✓ Inspection of encryption of information

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More security–using physical isolation technology

Physical isolation permits safety FPGA is never affected by external device, but sometimes may be allowed to export data. Generally, optical fiber is a good one-direction control medium.

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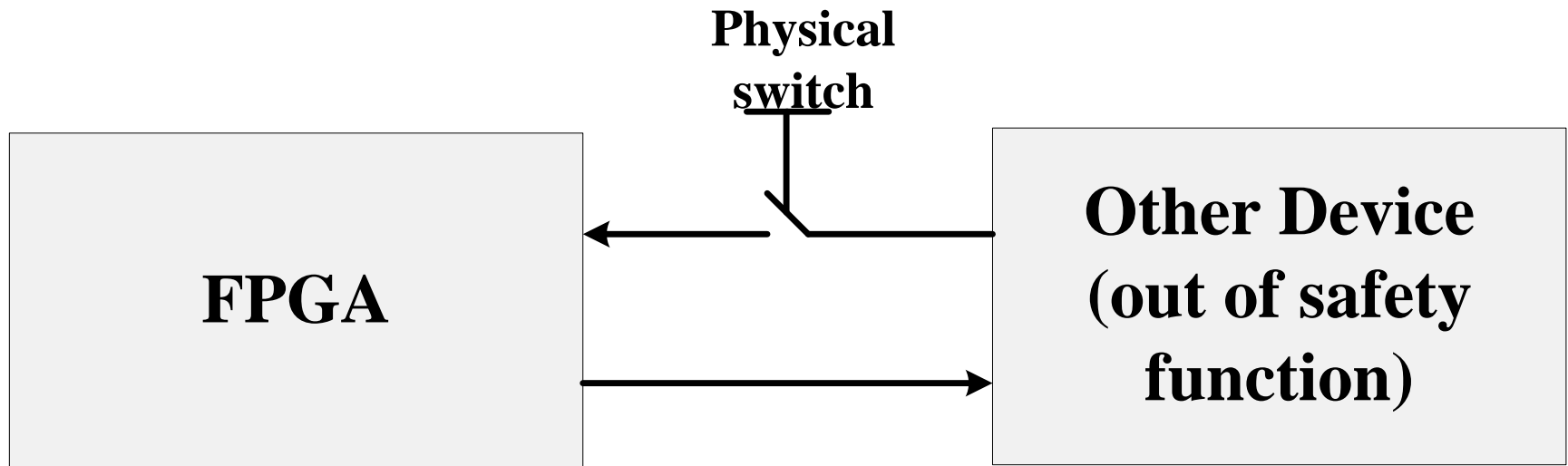
◆Conclusion

The NicSys8000N platform at least uses:

➢ six ways to enhance safety

➢ three ways to make it quicker

➢ two ways to simplify and ascertain

➢ three ways to ensure the security

The NicSys8000N platform is the most worth I&C system using for NPPs!

Questions ?

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Thanks!