



ROCK CREEK
INNOVATIONS, LLC

HIPS

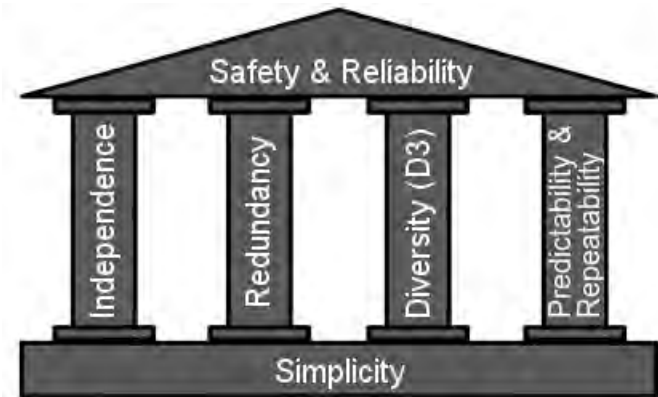
highly integrated protection system

Scalability of the HIPS Platform

Gregg Clarkson

October 11th, 2018

- The highly integrated protection system (HIPS) is designed to provide a robust platform for safety-related and important-to-safety applications
- Key design concepts incorporate the following fundamental design principles:
 - independence
 - redundancy
 - diversity and defense-in-depth (D3)
 - predictability and repeatability
- Hybrid analog and digital system with field programmable gate array (FPGA) logic on modules implementing multiple deterministic finite state-machines
- Design concepts support meeting requirements and guidelines for safety-related applications (RG 1.153, IEEE Std. 603, RG 1.152, IEEE Std. 7-4.3.2, DI&C-ISG-04, SECY-93-087)



- The HIPS platform comprised of just four module types.
 - Safety Function Module (SFM)
 - Communications Module (CM)
 - Equipment Interface Module (EIM)
 - Hardwired Module (HWM)
- The SFM, CM, and EIM are active modules. These 3 module types can be interconnected to implement from a single discrete safety channel up to a full reactor protection system consisting of many discrete safety channels across multiple divisions including system level actuation logic and voting.
- The HWM is a passive module for input and output of discrete hardwired signals.
- The analog and digital logic based system takes advantage of the well proven analog safety channel approach of existing protection system architectures while also taking advantage of digital logic to provide comprehensive diagnostics and self-testing capabilities.

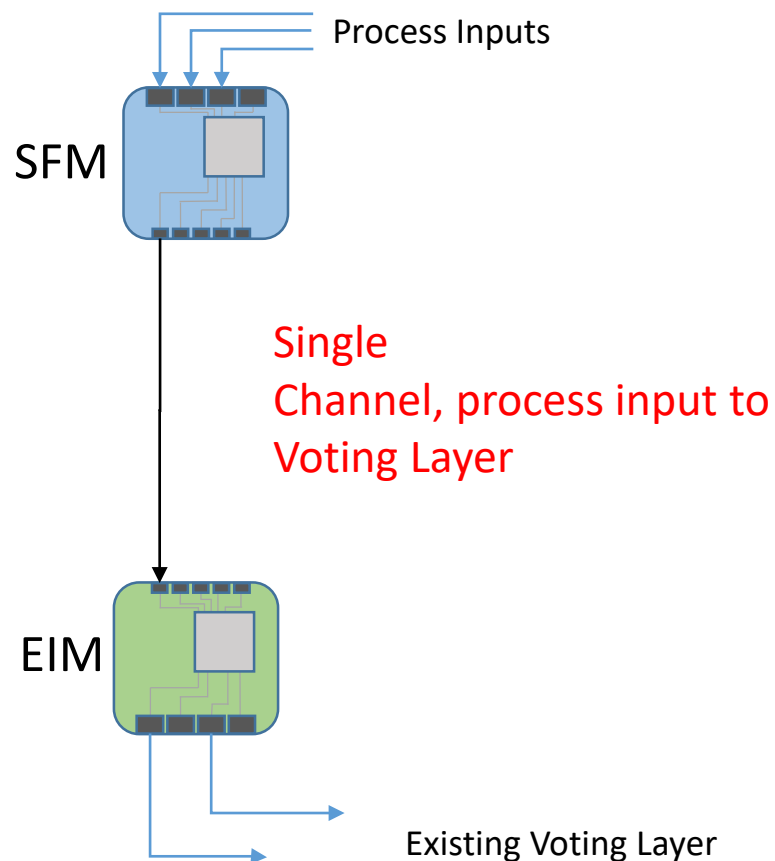
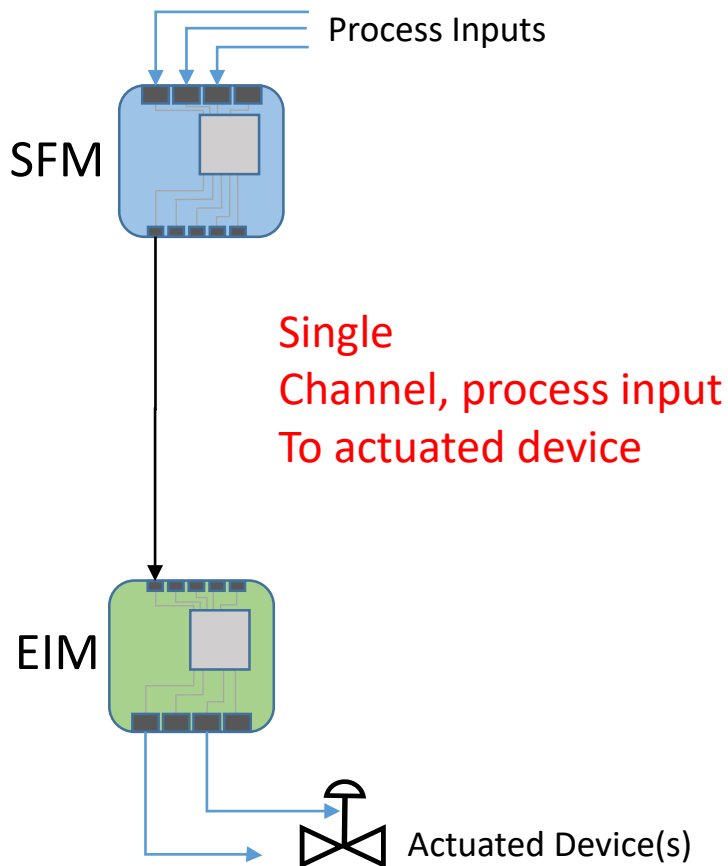
HIPS Module Types

Module Name	Abbreviation	Description/Use
Safety Function Module	SFM	Signal conditioning and actuation determination of safety function(s). Provides scaled value of input process to nonsafety controls and safety display for monitoring purposes (FPGA and analog).
Communications Module	CM	Controls, collects, and transmits information between HIPS modules or to external components (FPGA and analog).
Equipment Interface Module	EIM	Provides final equipment actuation output and includes priority logic circuitry for automatic and manual actuation inputs (FPGA and analog).
Hardwired Module	HWM	Converts hardwired contact inputs into logic levels for direct connection on dedicated backplane traces to a particular module as per the detail application design (analog only).

The HIPS platform is an FPGA-based platform – there is no executable software within the runtime environment

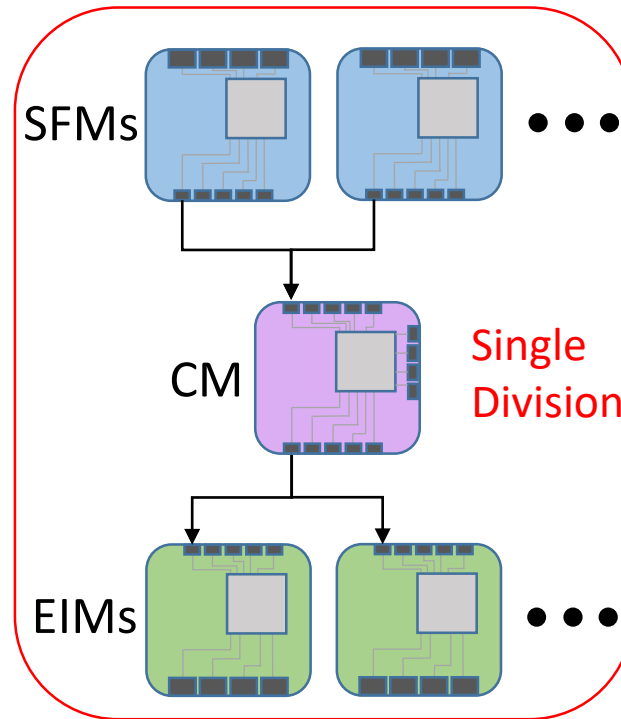
- Single Channel
 - Standalone channel from process input to actuated device output
 - Within an existing RPS, process input to existing voting layer
- Single Division
 - Replacement of an existing division for application such as Load Shed and Emergency Load Sequencers (LSELS)
- Two Division
 - Full implementation a LSELS or other 2 division safety systems, such as Plant Protection System in the NuScale design
- 3rd Process Input Division added to Two Division Architecture
 - Additional input redundancy without independent actuation & voting logic layer
- Independent Trip Determination, Actuation Logic & Voting
 - Full implementation of a reactor protection system, such as Module Protection System in the NuScale design or a 7300 Protection and SSPS replacement in an existing plant

Single Channel HIPS



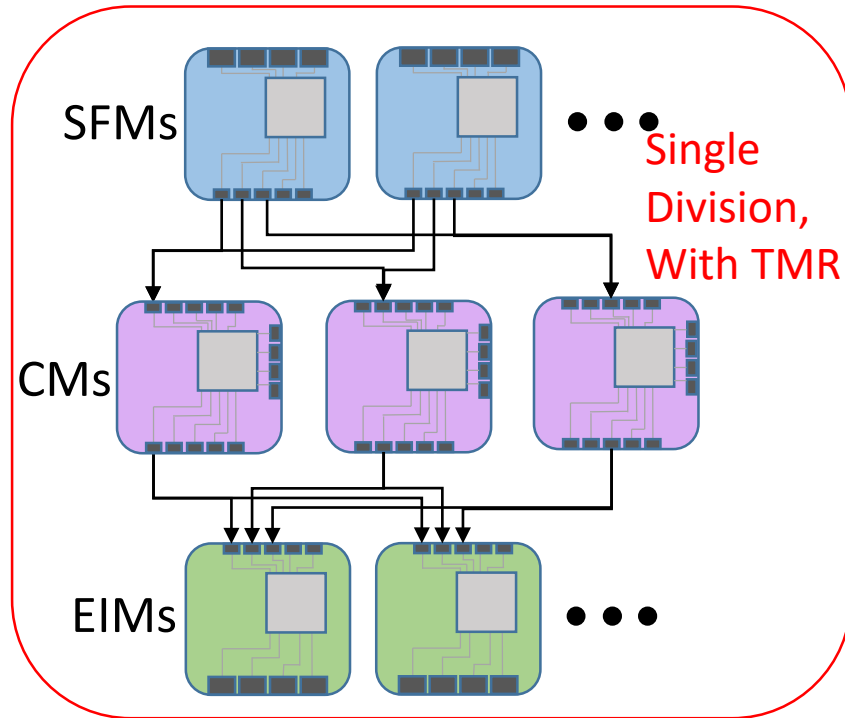
Single Division

Replacement of an existing division for application such as Load Shed and Emergency Load Sequencers (LSELS)



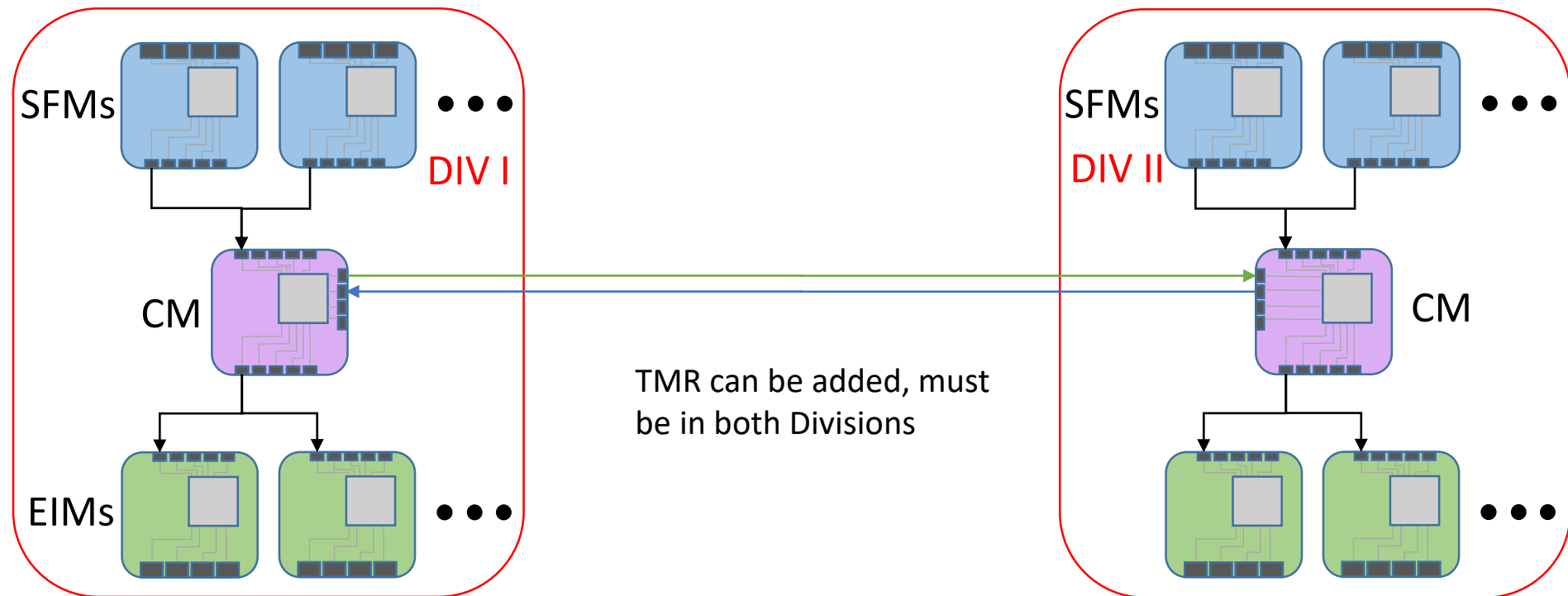
Single Division, with TMR

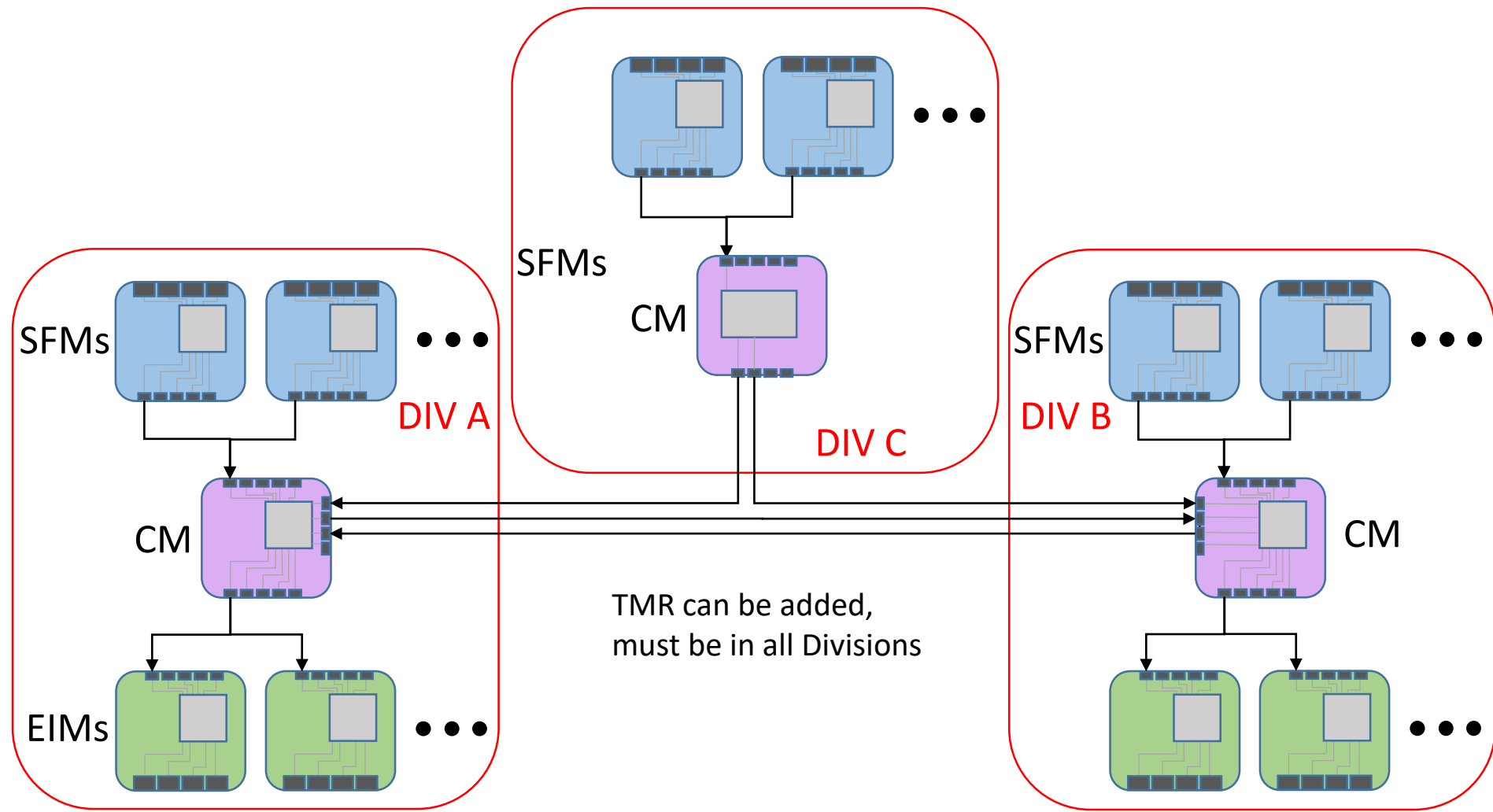
Replacement of an existing division for application such as Load Shed and Emergency Load Sequencers (LSELS)



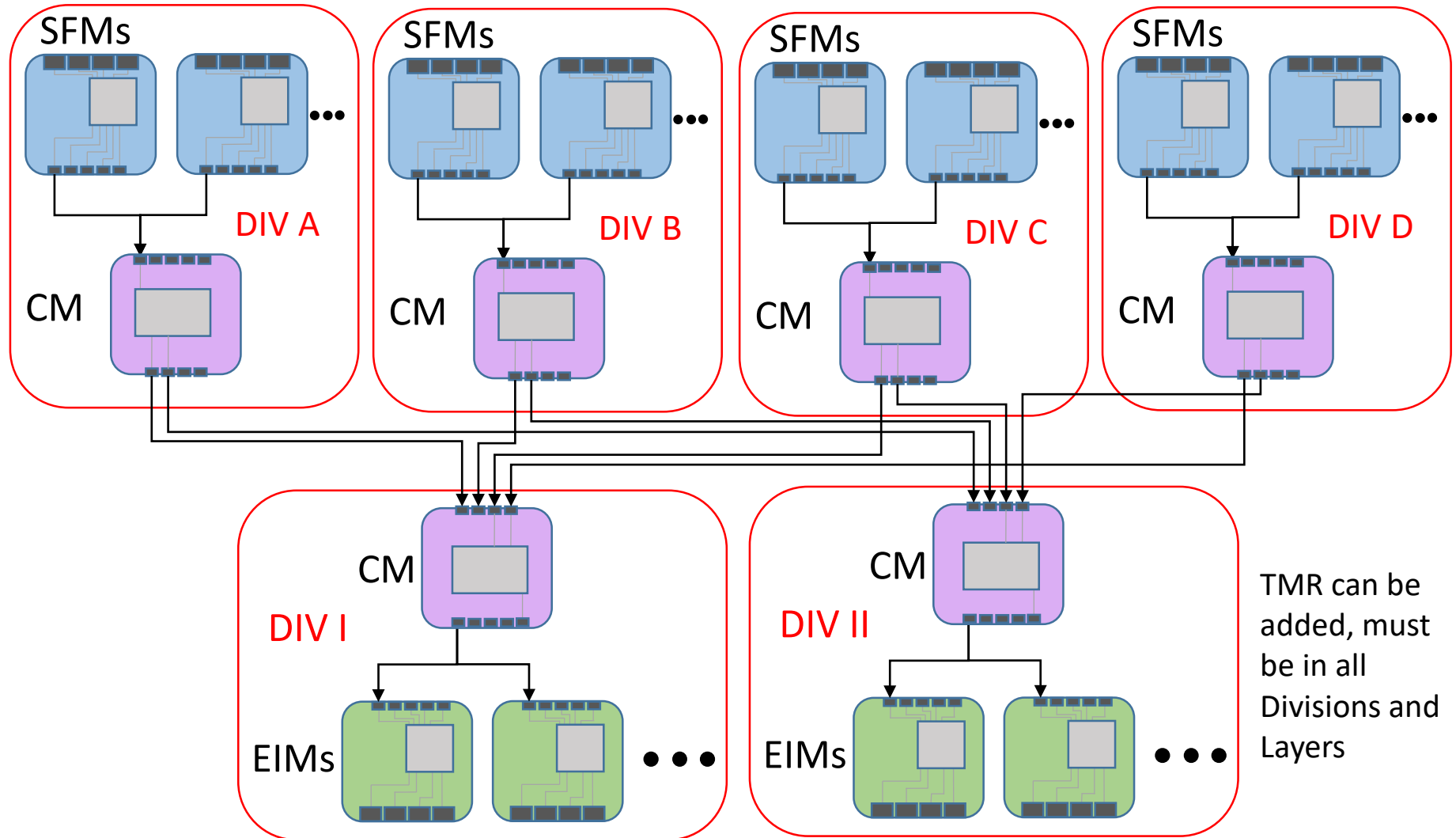
Two Division

Full implementation a LSELS or other 2 division safety systems, such as Plant Protection System in the NuScale design



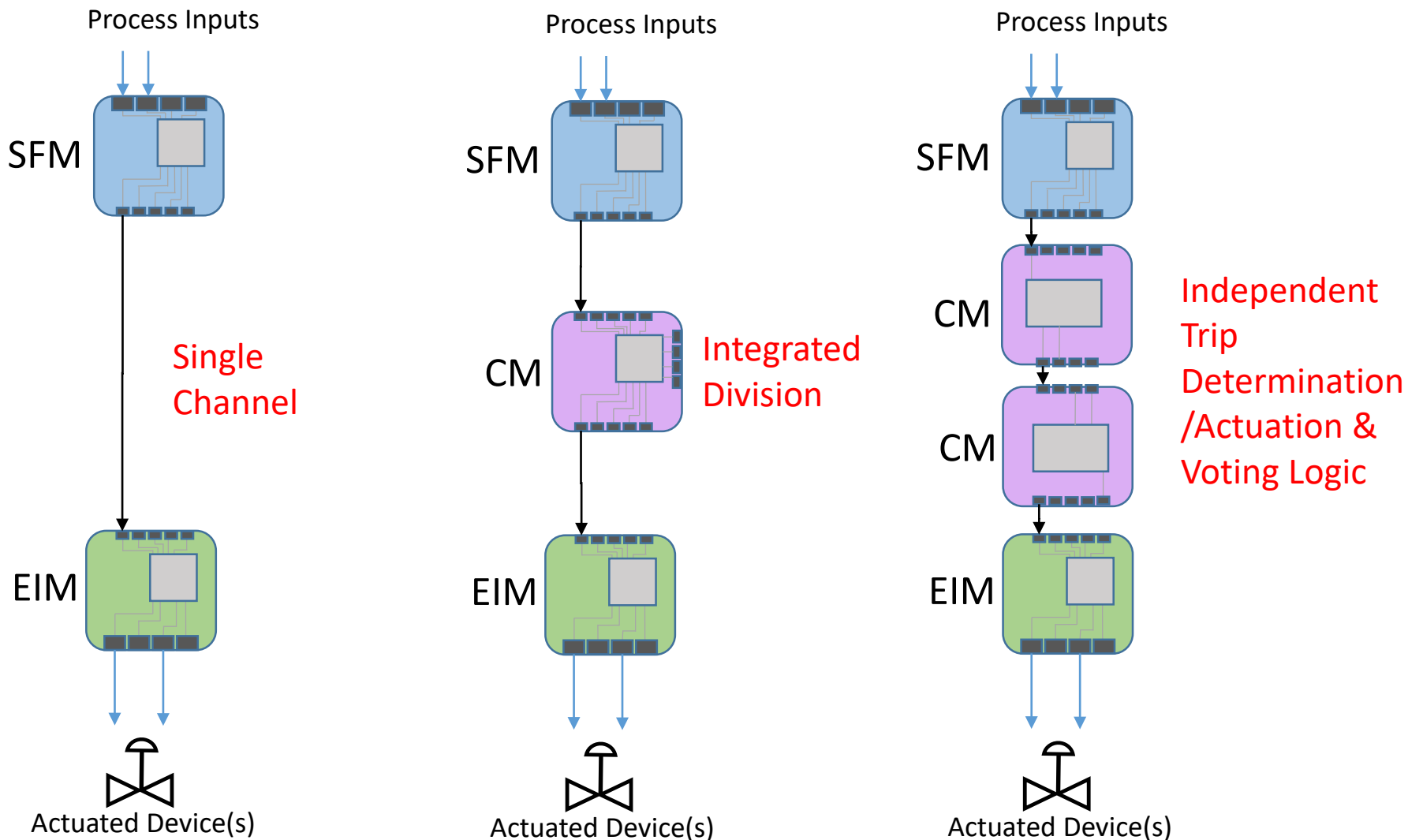


Independent Trip Determination, Actuation and Voting Logic



TMR can be added, must be in all Divisions and Layers

Independent Channel Architecture Maintained Throughout the Scalability



Summary

- The HIPS platform is designed around 4 module types: SFM, CM, EIM, and HWM
- The HIPS Platform is scalable from a single channel up to a layered full reactor protection system architecture
- The independent channel architecture is maintained throughout the entire architecture scalability of the HIPS Platform.